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FLIGHT TEST RESULTS OF A DAVI ISOLATED PLATFORM

By

Robert Jones

November 1970

U. S. ARMY AVIATION MATERIEL LABORATORIES
FORT EUSTIS, VIRGINIA

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KAMAN AEROSPACE CORPORATION

BLOOMFIELD, CONNECTICUT

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Under prior contracts, feasibility of the one-, two-, and three-dimensional Dynamic Antiresonant Vibration Isolator (DAVI) was established through analyses and controlled laboratory testing.

This contract was initiated to more fully assess the potential of this concept. A small rectangular platform, isolated at each corner by a DAVI, was installed in the cabin area of a UH-2 helicopter and flight tested, thereby subjecting the isolators to the rather complex multidirectional vibration environment typical of helicopters.

Test results of both the one- and two-dimensional configuration of the DAVI were disappointing. These configurations had an offset between the isolated pivot and the spring elastic axis. It was concluded that this offset causes resonant and antiresonant frequencies of the isolated platform's pitching and rolling modes to differ markedly from those in the translational response modes. Consequently, although the isolated platform was tuned to an antiresonance coincident with the principal frequency of excitation for the vertical (and longitudinal for two-dimensional DAVI) response mode, it was under the dominant influence of pitching and rolling modes, thus causing generally poor performance.

The pivot-spring offset was eliminated in the three-dimensional DAVIs, and in the ensuing flight test excellent vibration isolation was obtained. For all configurations tested, agreement between analyses and test was poor, primarily because the hub forces and moments used in the analyses only reasonably approximate the excitation of the isolated platform. Precise definition of the hub forces and moments that would reproduce the excitation vibration levels and phases obtained in the flight tests was not possible, thus precluding good correlation.

In related work, the DAVI concept was shown to be analytically feasible for helicopter rotor isolation for a number of configurations ranging from the LOH to the HLH. A full-scale experimental demonstration of this feasibility using the three-dimensional DAVI is currently under way.

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FLIGHT TEST RESULTS OF A DAVI ISOLATED PLATFORM

Kaman Report No. R-863

By

Robert Jones

Prepared by

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For

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Fort Eustis, Virginia

ABSTRACT

This report contains the results of a flight test evaluation of the Dynamic Antiresonant Vibration Isolator (DAVI). In this program, three series of tests were conducted for four different weight configurations of a DAVI isolated platform. The first series of tests evaluated the unidirectional DAVI, the second series of tests evaluated the two-dimensional DAVI, and the third series of tests evaluated the three-dimensional DAVI. The test results showed that the unidirectional and the two-dimensional DAVI isolated platforms did not achieve the expected reduction in vibration and, in some conditions, reduction was very poor. However, the reduction of vibration obtained on the three-dimensional DAVI isolated platform was excellent. A comparison of results obtained on the three-dimensional isolated platform and a conventionally isolated platform shows that the three-dimensional DAVI isolated platform had the lower vibration level and was less sensitive to changes in isolated weight or to changes in helicopter rotor speed (excitation frequency).

FOREWORD

This research program for the flight testing of the Kaman Dynamic Antiresonant Vibration Isolator (DAVI) was performed by Kaman Aerospace Corporation, Division of Kaman Corporation, under Contract DAAJ02-67-C-0060, for the U. S. Army Aviation Materiel Laboratories, Fort Eustis, Virginia.

The program was conducted under the technical direction of Mr. J. H. McGarvey, Contracting Officer's Representative.

Principal Kaman personnel in this program were Messrs A. D. Rita and W. Braem, Flight Test Engineers; E. P. Schuett, Research Engineer; and R. Jones, Chief of Aeromechanics Research.

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LIST OF SYMBOLS

a	distance from the pivot axis to the springs, ft
b	distance from the cg to the isolated pivot, ft
e	distance from the cg to the pivot axes, ft
r	distance between the isolated and non-isolated pivots, ft
K_D	spring rate of the DAVI, lb/ft
M_A	effective mass of the DAVI inertia at antiresonance, slugs
ω_A	antiresonant frequency of the DAVI for a translational input, rad/sec
ω_{A_1}	antiresonant frequency of the DAVI with offset springs equally distant from the pivot axis for a rotational input, rad/sec
ω_{A_2}	antiresonant frequency of the DAVI, including the effect of offset between the isolated and non-isolated pivots for a rotation input

INTRODUCTION

Research on the Dynamic Antiresonant Vibration Isolator (DAVI) was sponsored by the U. S. Army Aviation Materiel Laboratories (USAAVLABS) under Contract DA 44-177-AMC-196(T) and Contract DA 44-177-AMC-391(T). The results of this research are reported in References 1 and 2, wherein it was shown that the DAVI, which is a passive vibration isolator, can provide a high degree of isolation at low frequency with very low static deflection. At a predetermined antiresonant frequency, the nearly zero transmissibility across a DAVI is independent of the isolated mass. The analysis and test showed that the DAVI gives significantly better shock isolation than a standard isolator with the same spring rate.

However, this experimental research was conducted under controlled laboratory conditions. Further research was required to determine the performance of the DAVI subject to an actual helicopter vibratory environment, to determine possible design change requirements when subject to such an environment, and to determine the number of directions of DAVI isolation required to obtain good vibration reduction. Therefore, unidirectional, two-dimensional, and three-dimensional DAVI's were tested. Unidirectional DAVI flight testing was done while two-dimensional and three-dimensional DAVI's were concurrently being laboratory tested upon the conclusion of which they, too, were flight tested. In all cases, exploratory flight tests were conducted with only nominal changes made to improve performance prior to execution of each flight test plan.

The DAVI platform used in this flight test program was essentially the same as that used in the previous USAAVLABS contracts, reported in References 1 and 2, requiring only minor modification for installation in the Kaman UH-2 helicopter. The unidirectional DAVI's were installed such that the DAVI isolation occurred only in the vertical direction and the system was essentially rigid in the lateral and longitudinal directions. The two-dimensional DAVI's were installed such that the DAVI isolation occurred in the vertical and longitudinal directions and was essentially rigid in the lateral direction. The three-dimensional DAVI's gave isolation in the vertical, lateral, and longitudinal directions. All three DAVI configurations were tuned to give an antiresonance at 18.5 cps, which is the predominant excitation of the UH-2B helicopter at 100 percent rotor rpm and of the UH-2C helicopter at 98 percent rotor rpm.

The flight test program consisted of similar steady-state and maneuver conditions for the three DAVI configurations. For all three DAVI configurations, platforms with payloads of 50, 150, and 200 pounds and 200 pounds with a three-inch center of gravity offset were test flown. For the unidirectional DAVI isolated platform, very good reduction in vertical vibration was obtained on the 50-pound platform for the 30-knot and 120-knot steady-state conditions. Reduction in vertical vibration was also obtained for the other platform weights at 120 knots. However, at the 30-knot steady-state flight conditions, with 150-pound, 200-pound, and 200-pound with a three-inch center of gravity offset platforms, the results were poor. These poor results are attributed to lateral and longitudinal inputs not being isolated by the unidirectional DAVI and introducing pitching and rolling of the platform.

In the series of tests made on the two-dimensional DAVI isolated platform, three different types of pivots were tested. The pivot configurations were flexural, spherical bearing, and rubber type. Also in this series of tests, a platform with conventional isolation was tested. The two-dimensional DAVI's were designed with a large offset between the spring axis and the isolated pivot, as seen in Figure 1.

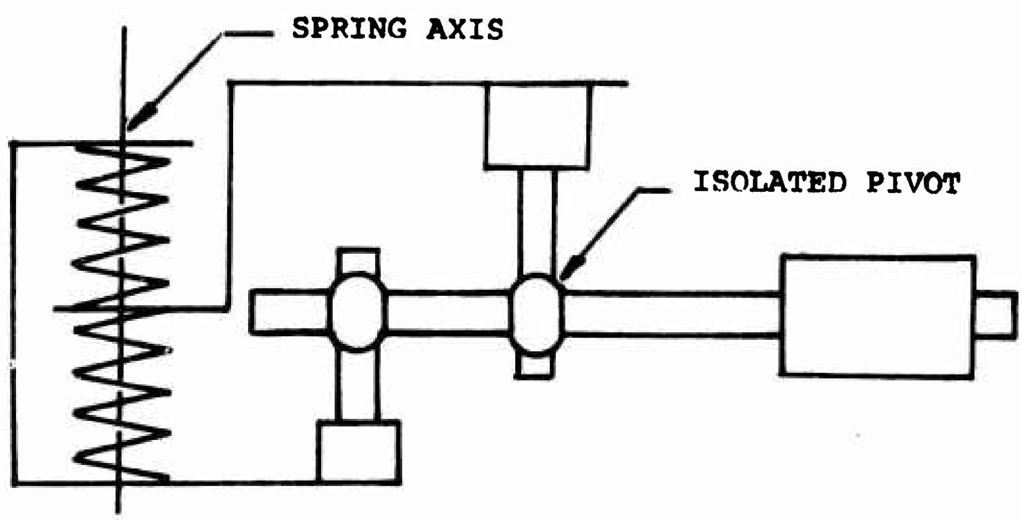

Figure 1. Schematic of Two-Dimensional DAVI.

The reason for this type of design was easy interchange of the pivot configurations to be tested. It was realized at the time of the design that the offset of the pivots from the spring axis would introduce a couple into the isolated platform; however, this couple would be cancelled with the proper orientation of the DAVI's in the system.

For the pivot configuration tested, the reduction of vibration obtained on the platform for all weight configurations was poor. In fact, for the 50-pound and 150-pound platforms, large amplification was obtained. This was attributed to the offset between the pivots and the springs. It was determined that although the couple was cancelled by orientation of the DAVI for pure translational inputs, the antiresonant frequency due to a rotational input was not the same as that for a translational input.

The results obtained from the series of tests made on the three-dimensional DAVI isolated platform were excellent. For all weight configurations of the platform, a reduction of vibration was obtained. In comparing these results to an equivalent conventional isolation system tested, the three-dimensional DAVI had a lower vibration level and was less sensitive to change in isolated weight or to change in helicopter rotor speed (excitation frequency).

DAVI PLATFORM CONFIGURATIONS

DAVI MODELS

The unidirectional DAVI models used in this flight test program were the same ones used in the USAAVLABS program under Contract DA 44-177-AMC-391(T). The results of that study are reported in Reference 2. These DAVI models were designed to have a variable r* from .75 inch to 2.0 inches. Without changing any of the physical hardware, an anti-resonance can be obtained from 4 cps to 30 cps. Figure 2 shows the unidirectional DAVI used in this program.

Figures 3, 4, and 5 show the two-dimensional DAVI models used in this flight test program. Figure 3 shows the two-dimensional DAVI utilizing spherical bearings as the pivots. Figure 4 shows the two-dimensional DAVI utilizing flexural pivots as a universal joint. Figure 5 shows the two-dimensional DAVI utilizing rubber working in shear as the pivot. The supports produce an effective pivot distance, and load application causes rotation of the bar.

The three-dimensional DAVI models used in this program were the same ones used in the USAAVLABS program under Contract DAAJ02-69-C-0003. The results of this study are reported in Reference 3. Figures 6 and 7 show a photograph and schematic, respectively, of the three-dimensional DAVI, which requires two inertia bars. The unidirectional inertia bar couples with motion along the vertical axis of the spring, and utilizes Bendix flexural pivots for the input pivot and a spherical bearing for the isolated pivot. The isolated pivot is on the vertical elastic axis of the springs. The two-dimensional bar couples with the in-plane motions of the springs and utilizes spherical bearings for both the isolated and input pivots. The input pivot of the two-dimensional inertia bar and the isolated pivot of the unidirectional inertia bar make up a common pivot. The isolated pivot of the two-dimensional inertia bar is on the in-plane elastic axes of the spring system. Table I gives a summary of the physical parameters of the DAVI models used in the flight test program.

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*r is the distance between pivots

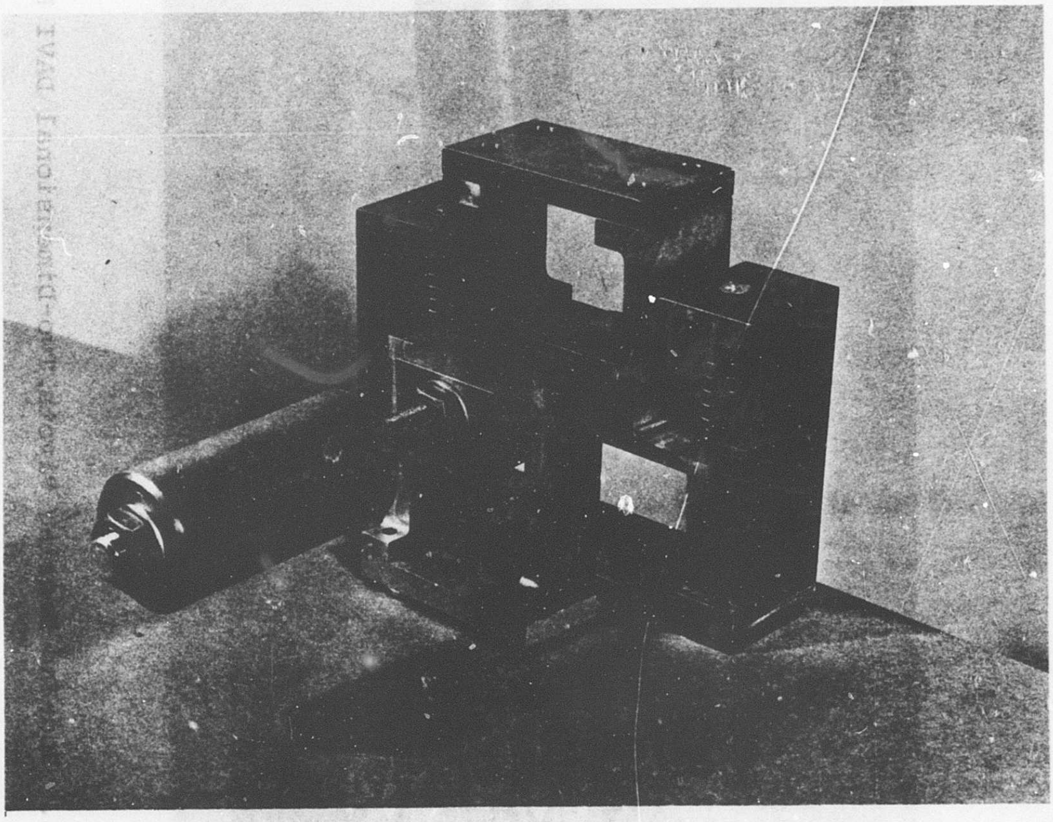


Figure 2. Unidirectional DAVI Model.

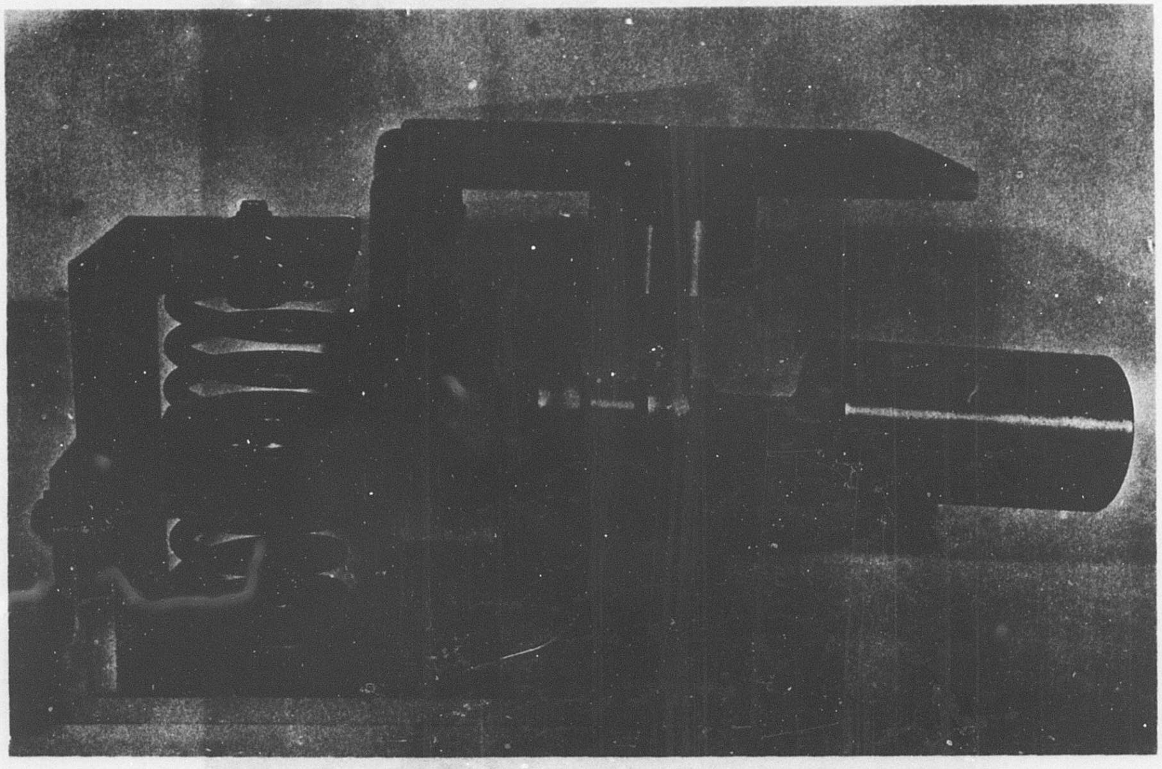


Figure 3. Rod-End Bearing Pivots, Two-Dimensional DAVI Model.

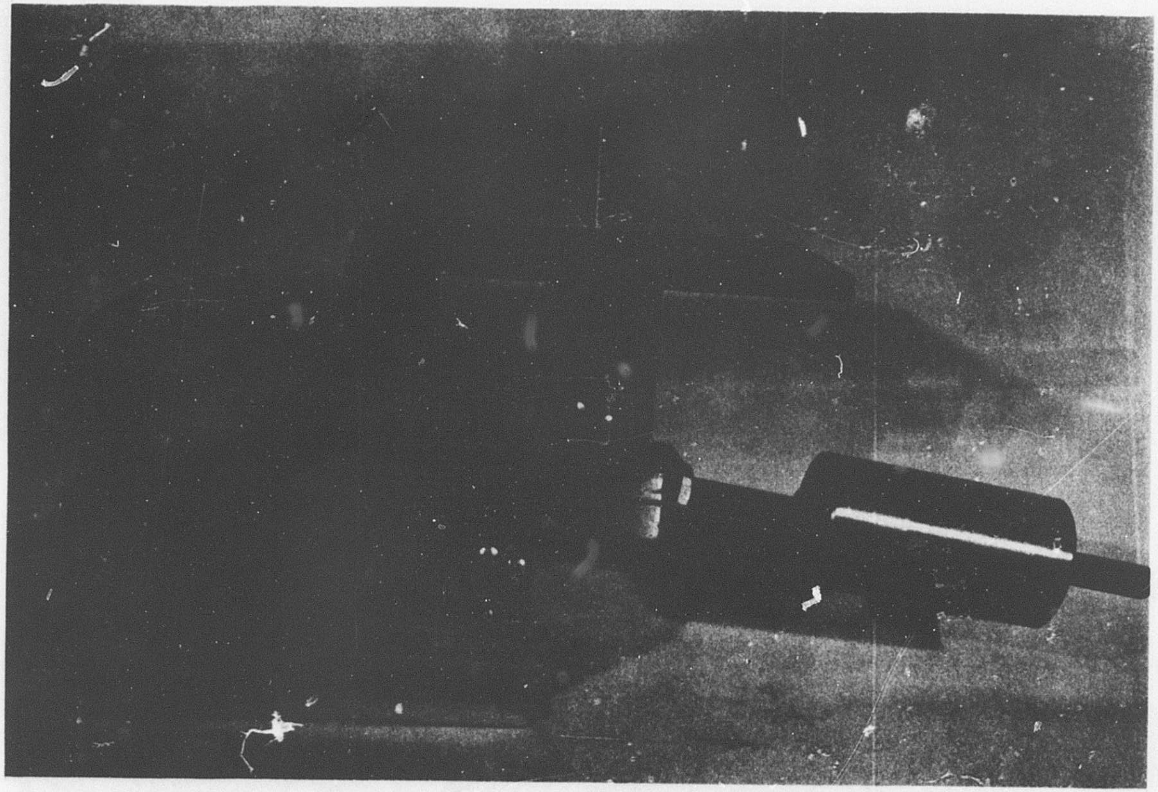


Figure 4. Flexural Pivots, Two-Dimensional DAVI Model.

Figure 5. Rubber Pivots, Two-Dimensional DAVI Model.

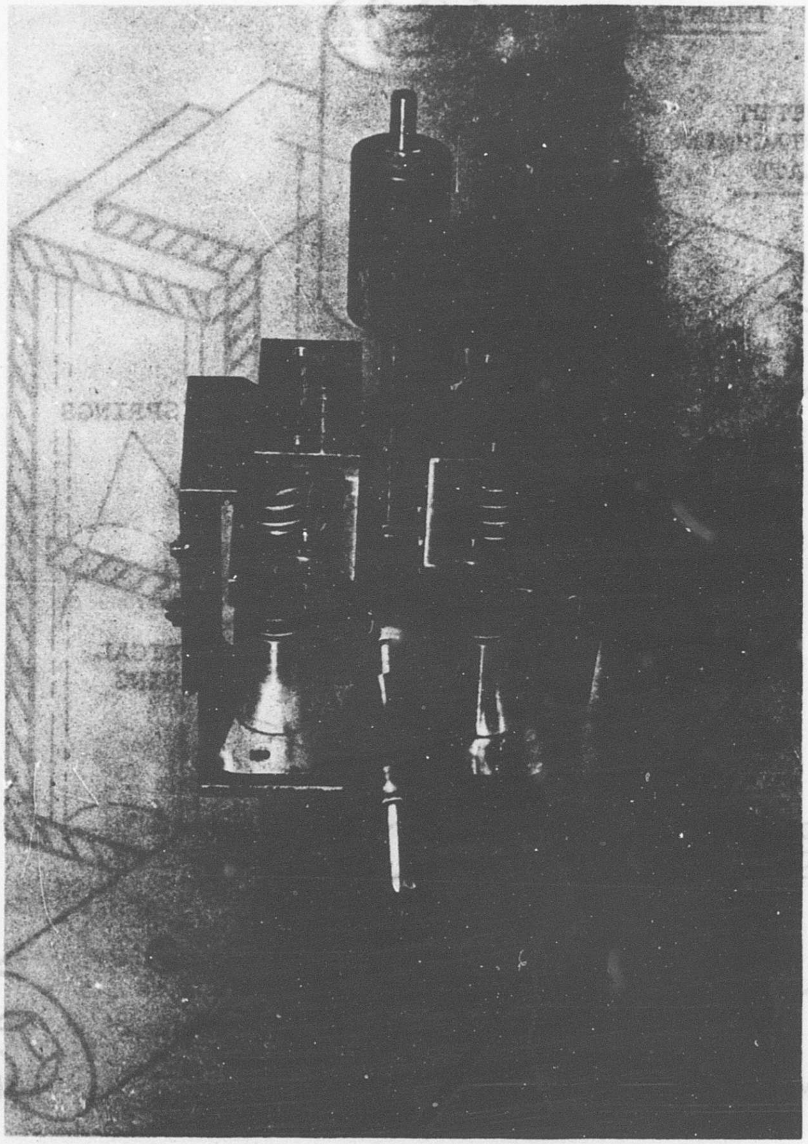


Figure 6. Three-Dimensional DAVI Model.

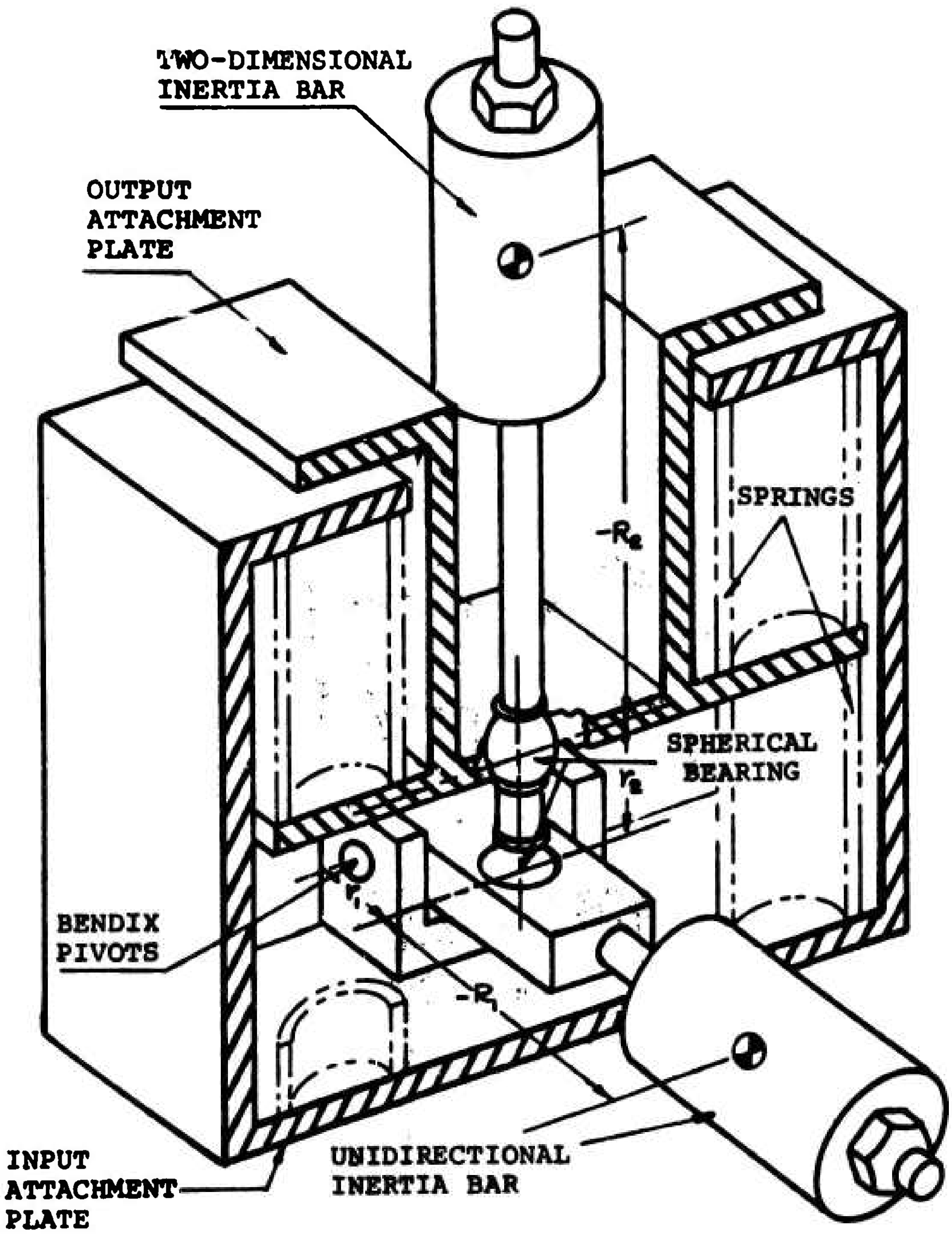


Figure 7. Schematic of the Three-Dimensional DAVI.

TABLE I. PHYSICAL PARAMETERS OF THE DAVI

Principal Axis	Unidirectional			Two-Dimensional									Three-Dimensional		
				Spherical Bearings			Flexural Pivots			Rubber Pivots					
	K (lb/in.)	r (in.)	Inertia Bar Weight (lb)	K (lb/in.)	r (in.)	Inertia Bar Weight (lb)	K (lb/in.)	r (in.)	Inertia Bar Weight (lb)	K (lb/in.)	r (in.)	Inertia Bar Weight (lb)	K (lb/in.)	r (in.)	Inertia Bar Weight (lb)
Vertical	400	1.8	2.25	400	1.0	1.15	400	1.0	1.15	200	1.0	1.15	400	1.0	1.15
Longi-tudinal	Rigid	-	-	400	1.0	1.15	400	1.0	1.15	200	1.0	1.15	400	1.0	1.15
Lateral	Rigid	-	-	Rigid	-	-	Rigid	-	-	-	1.0	1.15	400	1.0	1.15

FLIGHT TEST VEHICLE

The flight test program utilized Government-owned Kaman UH-2 helicopters. The unidirectional DAVI models were tested on UH-2B helicopter BuNo 147978, and the two-dimensional DAVI models were tested on UH-2B helicopter BuNo 147204. The three-dimensional DAVI models were tested on UH-2C helicopter BuNo 147981. The Kaman UH-2 helicopter is a four-bladed servo flap controlled rotor system. The predominant excitation frequency of this helicopter is four-per-rev of the main rotor, which is 18.44 cps at 100 percent rotor rpm for the UH-2B models and 18.76 cps at 100 percent rotor rpm for the UH-2C model. All of the DAVI models were individually tuned to give an antiresonance at 18.5 cps, which is essentially the four-per-rev frequency of the main rotor at 100 percent rotor rpm for the UH-2B models and 98 percent rotor rpm for the UH-2C model.

TUNING OF THE DAVI MODELS

The tuning of all of the DAVI models was done on the contractor's anti-friction test fixture. Figure 8 shows the type of test setup used to tune the DAVI models. An electromagnetic shaker was connected to the base weight and was used for the excitation. Two velocity pickups were attached to the input and isolated weights. The outputs of these pickups were fed to a vibration meter and the results were manually recorded. The movable weight on the DAVI inertia bar was then manually adjusted to obtain the proper antiresonant frequency of 18.5 cps. The two inertia bars of the three-dimensional DAVI model were tuned to give the antiresonant frequency at 18.5 cps for the vertical and in-plane directions.

PLATFORM

The platform used in this flight test program is essentially the same as used in previous DAVI contracts and is described in Reference 1. The platform was modified for this contract by changing the top plate or isolated plate of the platform to a 20.25-inch-long by 18.25-inch-wide by 0.5-inch-thick steel plate. This served two purposes: the tare weight of the modified platform was 50 pounds and the center of gravity of the isolated platform above the DAVI pivot axis was reduced to 2.5 inches. 100 pounds and 150 pounds of 5.5-inch-diameter cylindrically shaped lead weights were located in the center of the 50-pound platform to obtain the 150-pound and 200-pound platform. This shape of lead weight was used to minimize the mass moment of inertia of the isolated platform. The 200-pound platform with a three-inch center of gravity was obtained by offsetting the 150 pounds in the lateral direction.

The unidirectional DAVI platform was installed in the cargo area of the Kaman UH-2 helicopter. The bottom plate of unisolated plate was bolted to the cargo floor at the cargo tie-down points. Figure 9 is a schematic of the installation of the unidirectional DAVI platform in the UH-2 helicopter and Figure 10 shows the unidirectional isolated platform in the Kaman UH-2 helicopter. The two-dimensional and three-dimensional DAVI isolated platforms were installed in the UH-2 helicopter in the same manner. Both were modified to reduce the vertical distance of the center of gravity of the platform to be in line with the pivot axis of the DAVI. This modification is shown in Figure 11.

INSTRUMENTATION

For all of the DAVI platform configurations tested, ten accelerometers were used. For the unidirectional DAVI platform, four accelerometers were installed on the isolated platform, one in each corner approximately above each DAVI isolated pivot, to obtain the vertical accelerations of the isolated platform and four accelerometers were installed on the lower plate (input source), one approximately under each of the upper accelerometers, to obtain the vertical acceleration inputs to the isolated platform. Two accelerometers were installed on the lower plate (input source) to determine the lateral and longitudinal acceleration inputs to the isolated platform.

For the two-dimensional and three-dimensional platforms, five accelerometers were installed on the isolated platform, one in each forward corner of the platform and one at approximately the center of gravity of the platform, to obtain vertical accelerations. Two accelerometers were installed at approximately the center of gravity of the platform to obtain the lateral and longitudinal accelerations. Five accelerometers were installed on the lower plate (input source), one approximately under each of the upper or isolated plate accelerometers, to obtain the vertical, lateral and longitudinal acceleration inputs to the isolated platform.

The outputs from all of the accelerometers were fed through the appropriate signal conditioning equipment and were permanently recorded on a twelve-inch oscillograph.

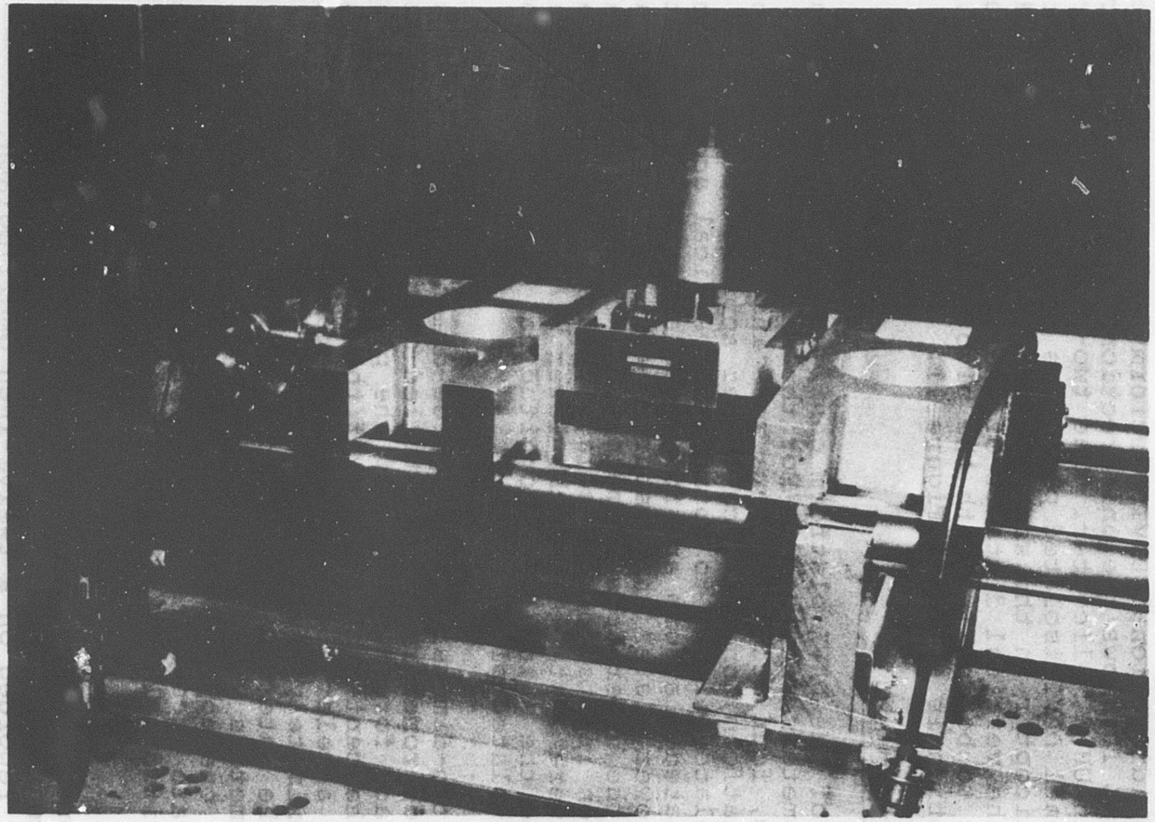


Figure 8. Test Setup for Tuning DAVI Models.

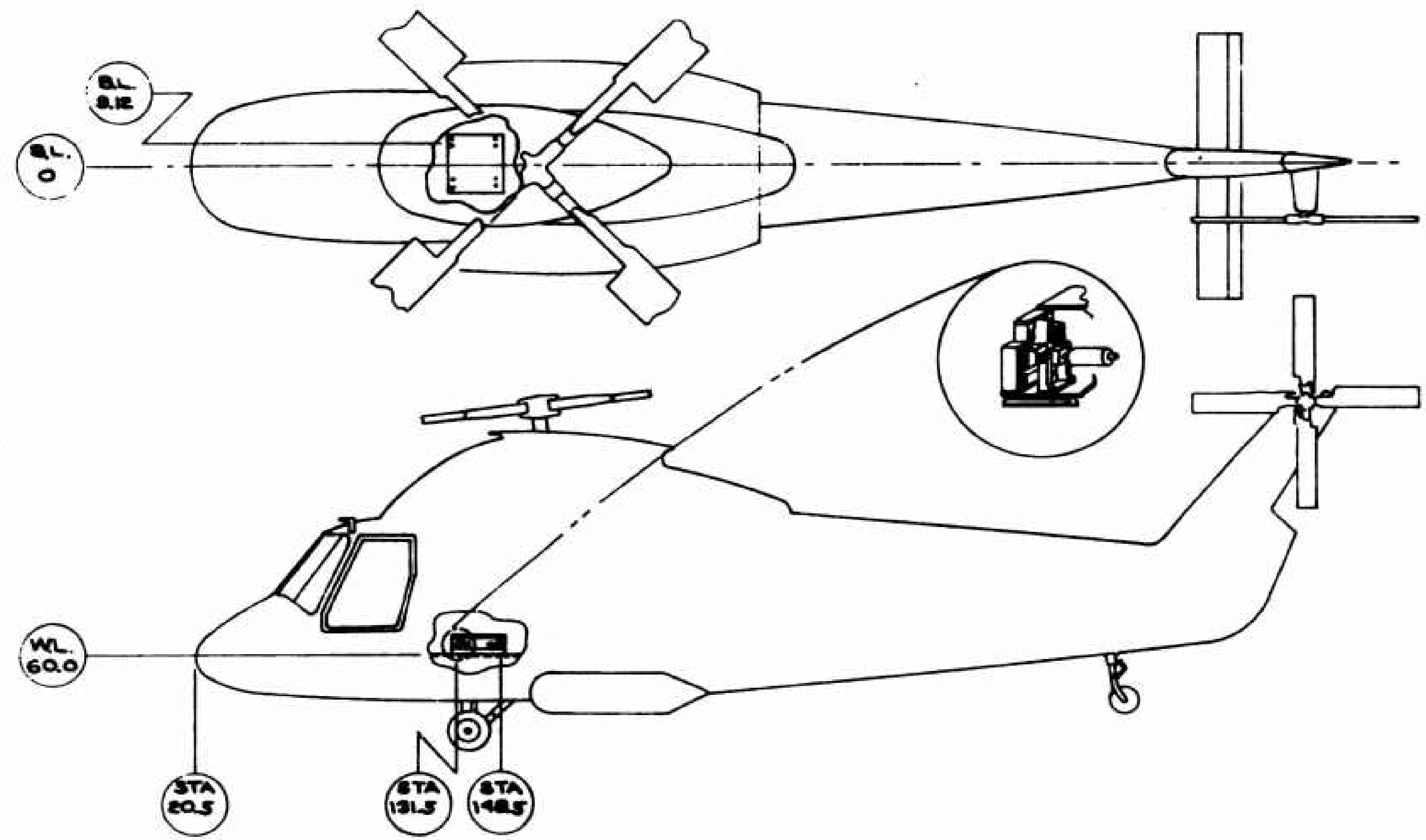


Figure 9. Schematic of Unidirectional DAVI Installed in Kaman UH-2 Helicopter.

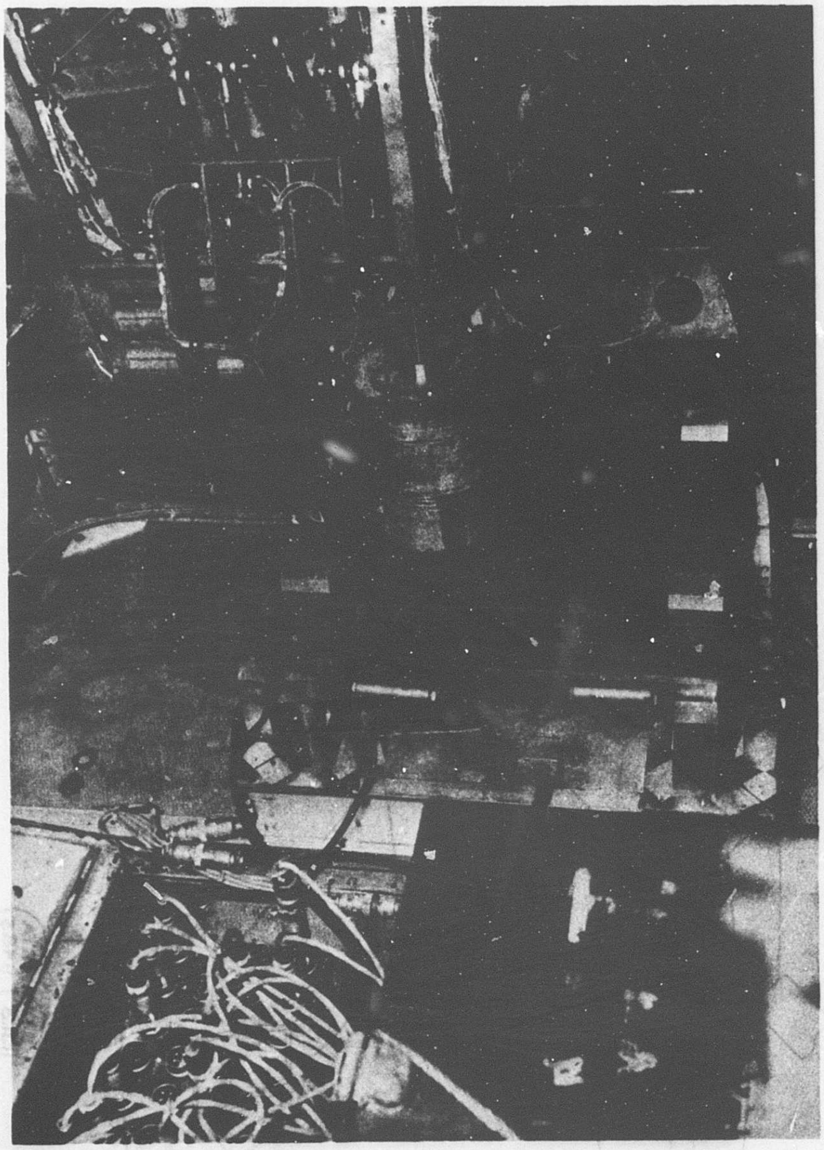


Figure 10. Unidirectional DAVI Isolated Platform Installed in the UH-2 Helicopter.

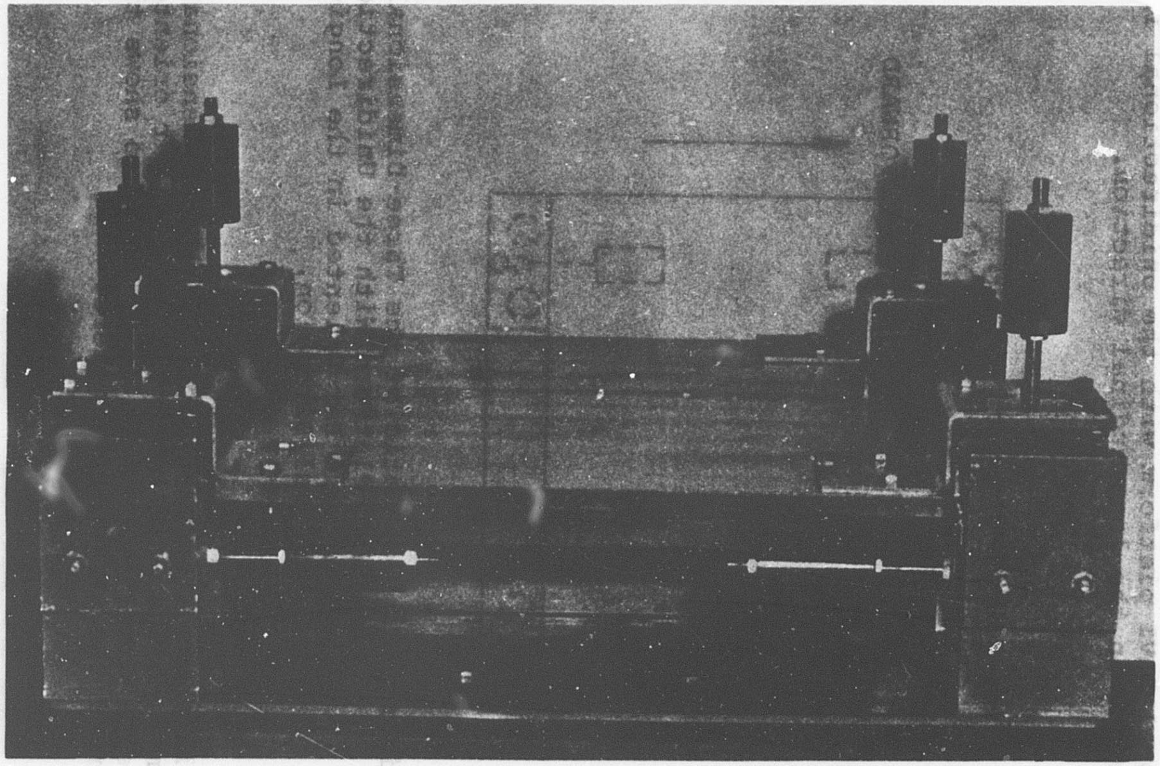


Figure 11. Three-Dimensional DAVI Isolated Platform.

THREE-DIMENSIONAL DAVI

THREE-DIMENSIONAL DAVI PLATFORM

Two three-dimensional DAVI platform configurations were tested. Figure 12 shows a schematic of the three-dimensional DAVI platform with the unidirectional inertia bar oriented in the longitudinal direction.

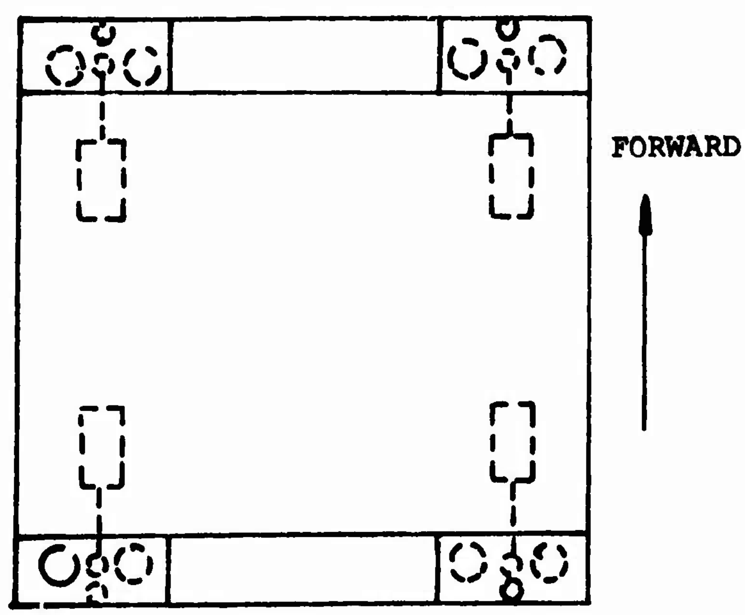


Figure 12. Schematic of the Three-Dimensional DAVI Platform With the Unidirectional Inertia Bar Oriented in the Longitudinal Direction.

Figure 13 shows a schematic of the three-dimensional DAVI platform with the unidirectional inertia bar oriented in the lateral direction. This schematic also shows the location of the ten accelerometers.

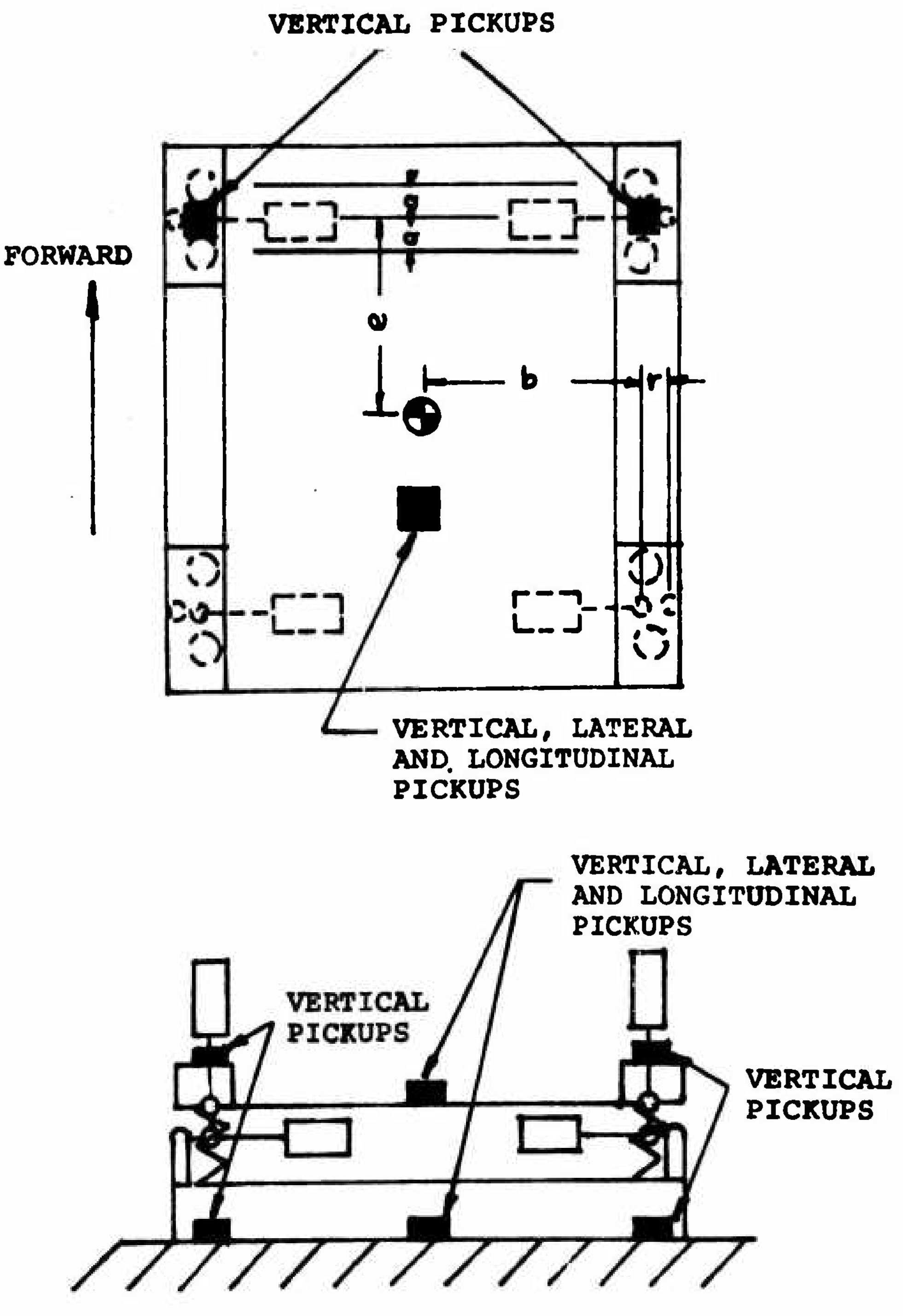


Figure 13. Schematic of the Three-Dimensional DAVI Platform With the Unidirectional Inertia Bar Oriented in the Lateral Direction.

The three-dimensional DAVI is designed such that the isolated pivots are on the elastic axis of the spring system to reduce internal coupling in the DAVI. However, as indicated in Figure 13, the springs are offset a distance (a) from the pivot axes of the DAVI inertia bar. This spring offset produces a different antiresonant frequency for a rotational input than for a translational input. Also the distance r between the non-isolated and isolated pivots produces a different antiresonant frequency for a rotational input than for a translational input. The antiresonant frequency for a translational input as obtained from Reference 2 is

$$\omega_A{}^2 = \frac{K_D}{M_A} \tag{1}$$

The antiresonant frequency for a DAVI with offset springs equally distant from the inertia bar for a rotational input is

$$\omega_{A_1}{}^2 = (1 + \frac{a^2}{e^2})\,\omega_A{}^2 \tag{2}$$

and the antiresonant frequency for a rotational input including the r effect is

$$\omega_{A_2}{}^2 = (\frac{1}{1 + r/b})\,\omega_A{}^2 \tag{3}$$

It is seen from these equations that different antiresonant frequencies are obtained depending upon the type of input and DAVI arrangement. In the three-dimensional DAVI isolated platforms tested, a >> e and b >> r, so that the difference in antiresonant frequencies was a minimum. However, two orientations of the unidirectional inertia bar were tested to determine the effects of the difference in antiresonance frequency on the response of the isolated platform.

For the two orientations of the three-dimensional DAVI, four different weights of the platform were tested: 50 pounds, 150 pounds, 200 pounds, and 200 pounds with a three-inch center of gravity offset in the lateral direction.

FLIGHT TEST CONDITIONS

The three-dimensional DAVI isolated platform was tested under steady-state or level flight conditions and transient conditions. The flight testing was conducted on Kaman UH-2C helicopter BuNo 147981. Table II gives the conditions tested. These were all tested for a helicopter gross weight of 9830 pounds.

FLIGHT TEST RESULTS

Figures 14 through 17 show typical oscillograph traces obtained in the level flight conditions. These figures show the results obtained on the three-dimensional DAVI platform for all weight configurations at 30 knots and at 98 percent rotor rpm. At this rotor speed the predominant four-per-rev excitation most nearly coincides with the tuned antiresonant frequency of the DAVIs. Isolation was obtained for all four weight configurations of the platform. Figures 18 through 21 show typical oscillograph traces obtained for the transient conditions of landing, which was more critical than rotor engagement. No abnormal g level was obtained for any of the weight configurations tested.

A 48-point Fourier analysis was done on the test data to obtain the magnitude of the predominant harmonics. This analysis was done on all of the steady-state test conditions. Table III gives the frequencies of the predominant harmonics of the UH-2C helicopter.

The Fourier analysis results are given in Table IV for the one-per-rev and eight-per-rev and in Figures 22 through 37 for the four-per-rev.

It is seen from Table IV that the one-per-rev and eight-per-rev vibration levels are in most cases of very low magnitude. In comparing the input to the isolated platform with the outputs on the isolated platform, the results are as expected. In most cases there is an increase in the one-per-rev vibration level on the isolated platform. This is expected, since the natural frequencies of the platform are above one-per-rev. However, the increase in vibration level was a minimum, and no actual one-per-rev problem on the platform occurred. In most cases a reduction of eight-per-rev vibration levels occurred on the platform. This is also as expected.

TABLE II. THREE-DIMENSIONAL DAVI ISOLATED PLATFORM FLIGHT TEST CONDITIONS

Platform Weight (lb)	Platform Center of Gravity Offset (in.)	Main Rotor Speed (% rpm)	Airspeed (kn)
50	0	92 to 106	30
50	0	96 to 106	120
50	0	100	Landing
50	0	0 to 100	Ground Rev-Up
150	0	92 to 106	30
150	0	96 to 106	120
150	0	100	Landing
150	0	0 to 100	Ground Rev-Up
200	0	92 to 106	30
200	0	96 to 106	120
200	0	100	Landing
200	0	0 to 100	Ground Rev-Up
200	3	92 to 106	30
200	3	96 to 106	120
200	3	100	Landing
200	3	0 to 100	Ground Rev-Up

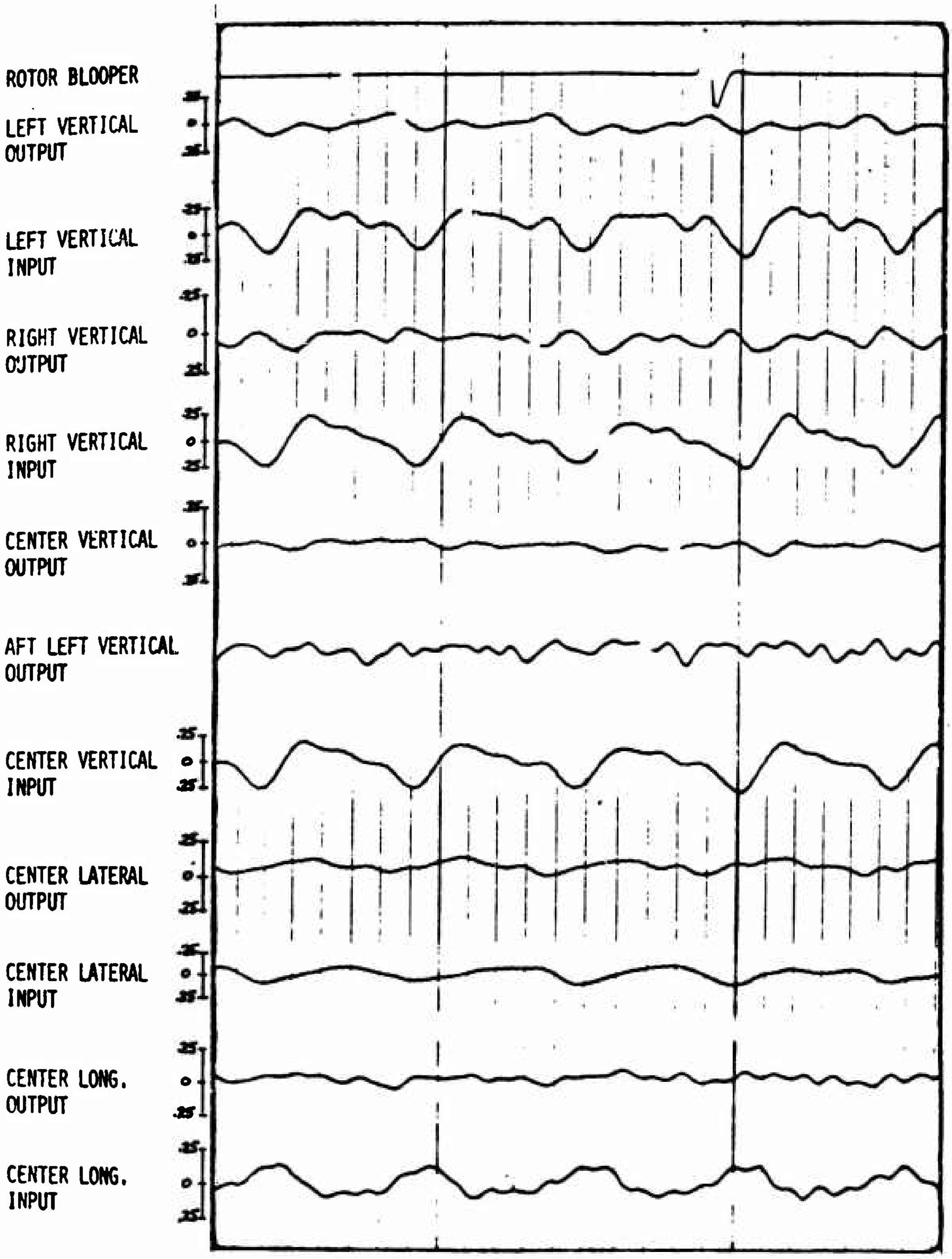


Figure 14. 50-Pound Three-Dimensional DAVI Platform Level Flight Oscillograph Traces.

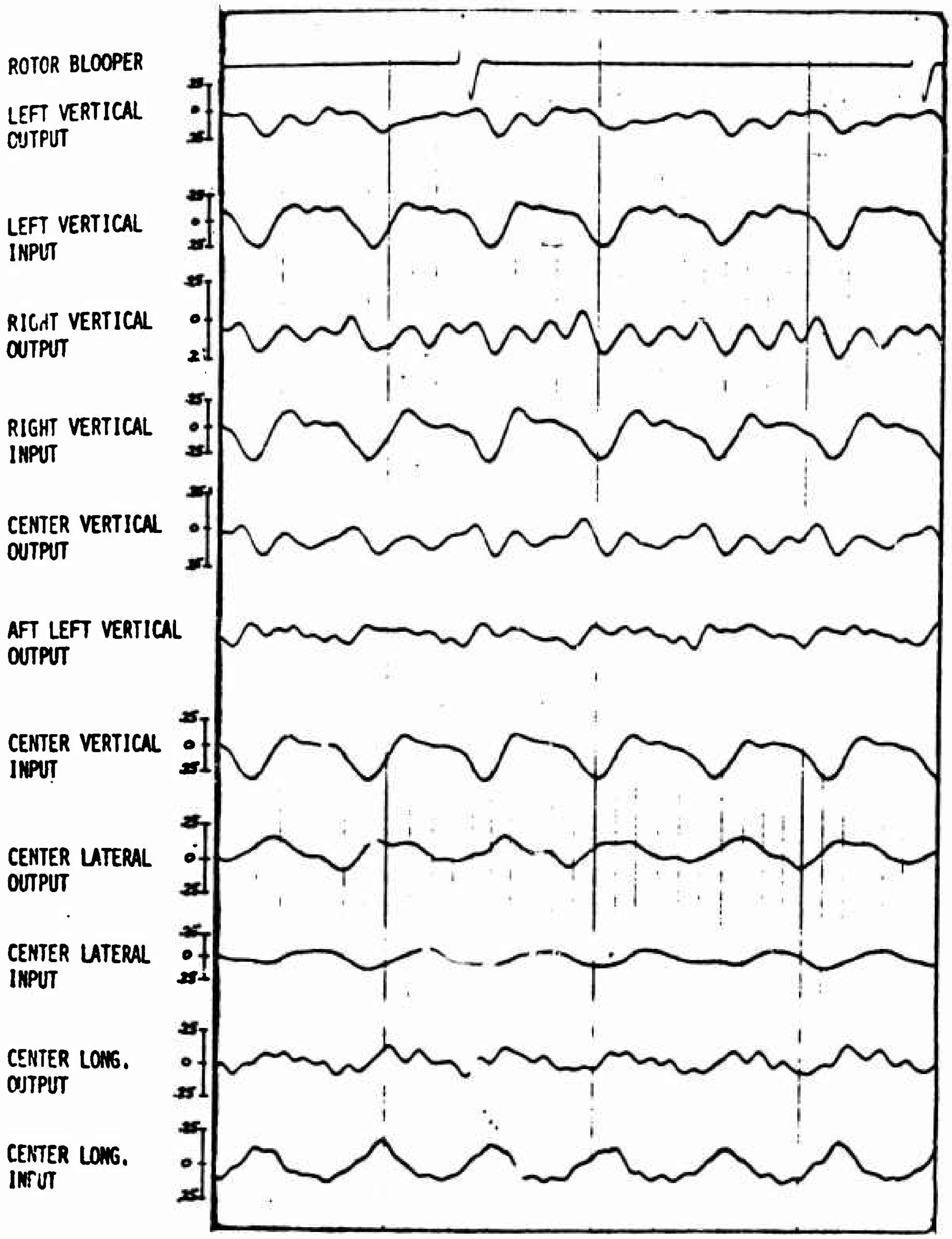


Figure 15. 150-Pound Three-Dimensional DAVI Platform Level Flight Oscillograph Traces.

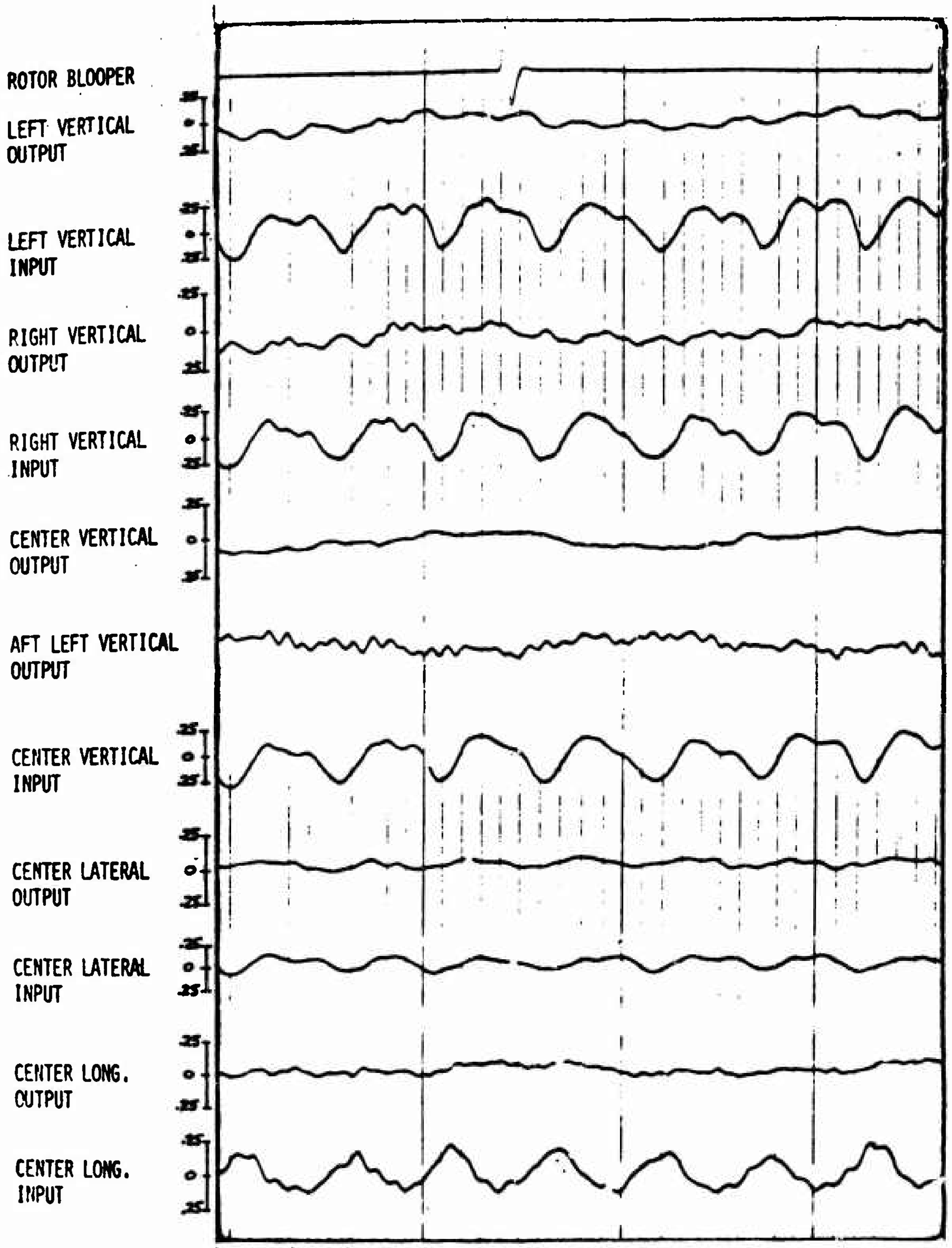


Figure 16. 200-Pound Three-Dimensional DAVI Platform Level Flight Oscillograph Traces.

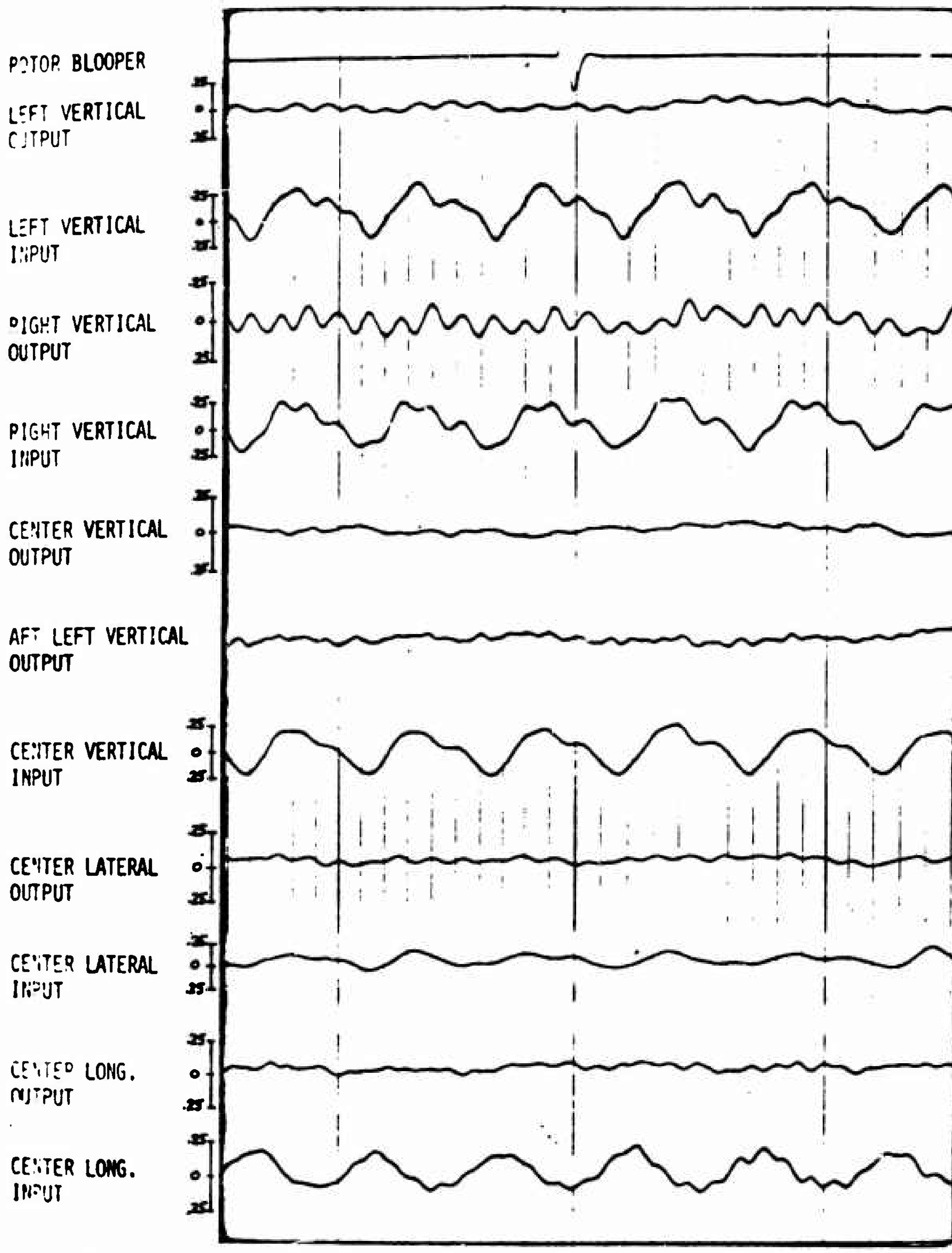


Figure 17. 200-Pound With a Three-Inch CG Offset Three-Dimensional DAVI Platform Level Flight Oscillograph Traces.

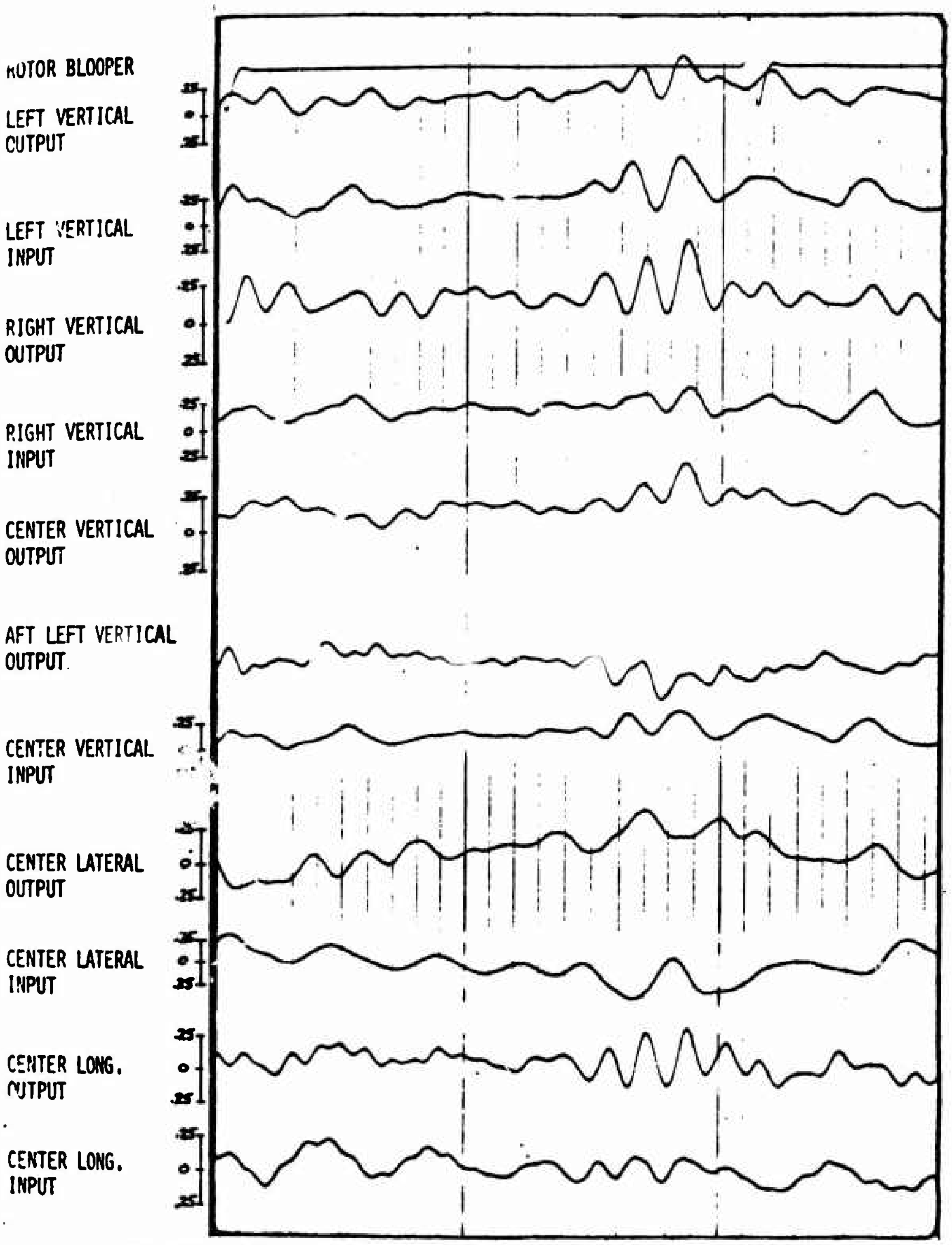


Figure 18. 50-Pound Three-Dimensional DAVI Platform Oscillograph Traces of the Landing Condition.

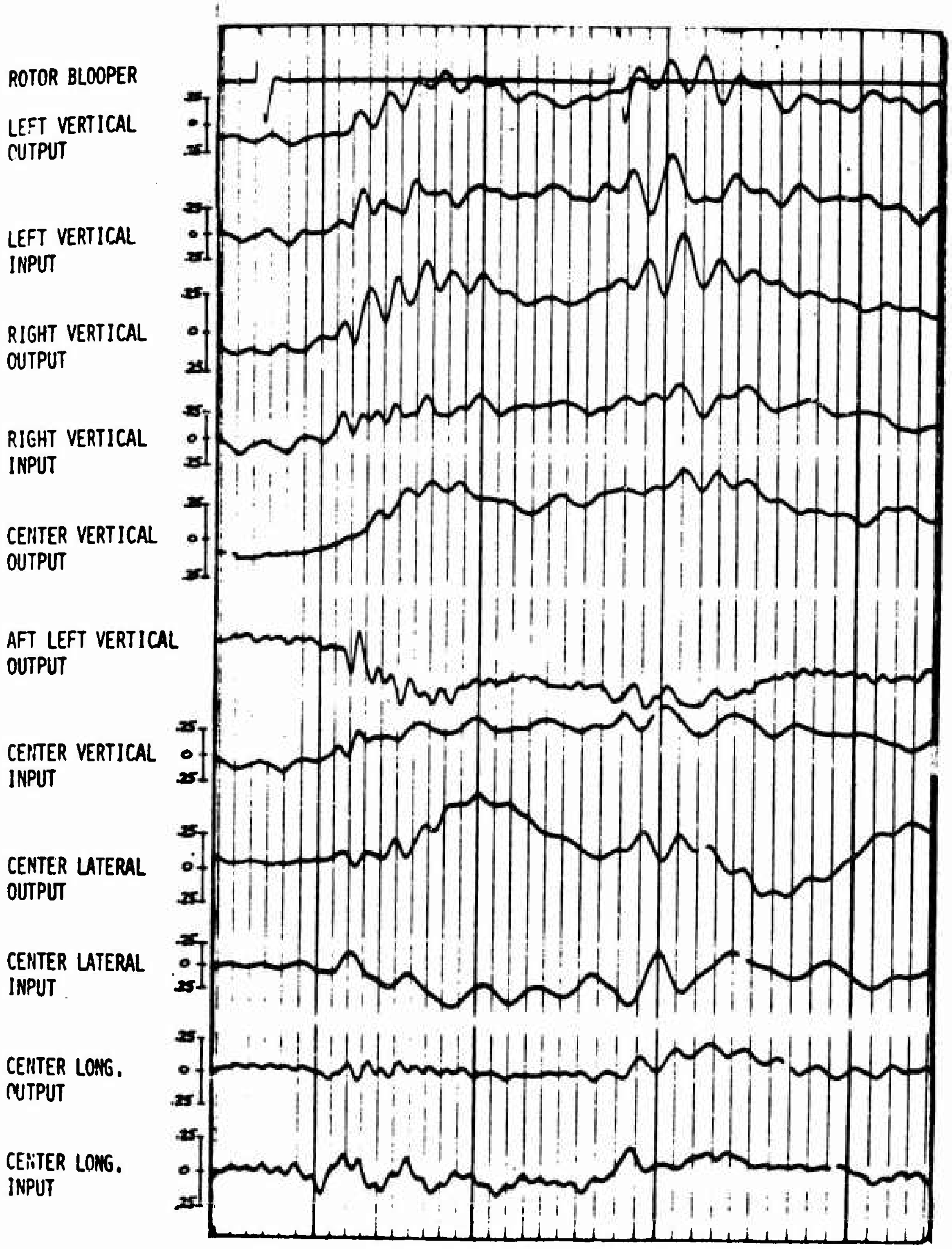


Figure 19. 150-Pound Three-Dimensional DAVI Platform Oscillograph Traces of the Landing Condition.

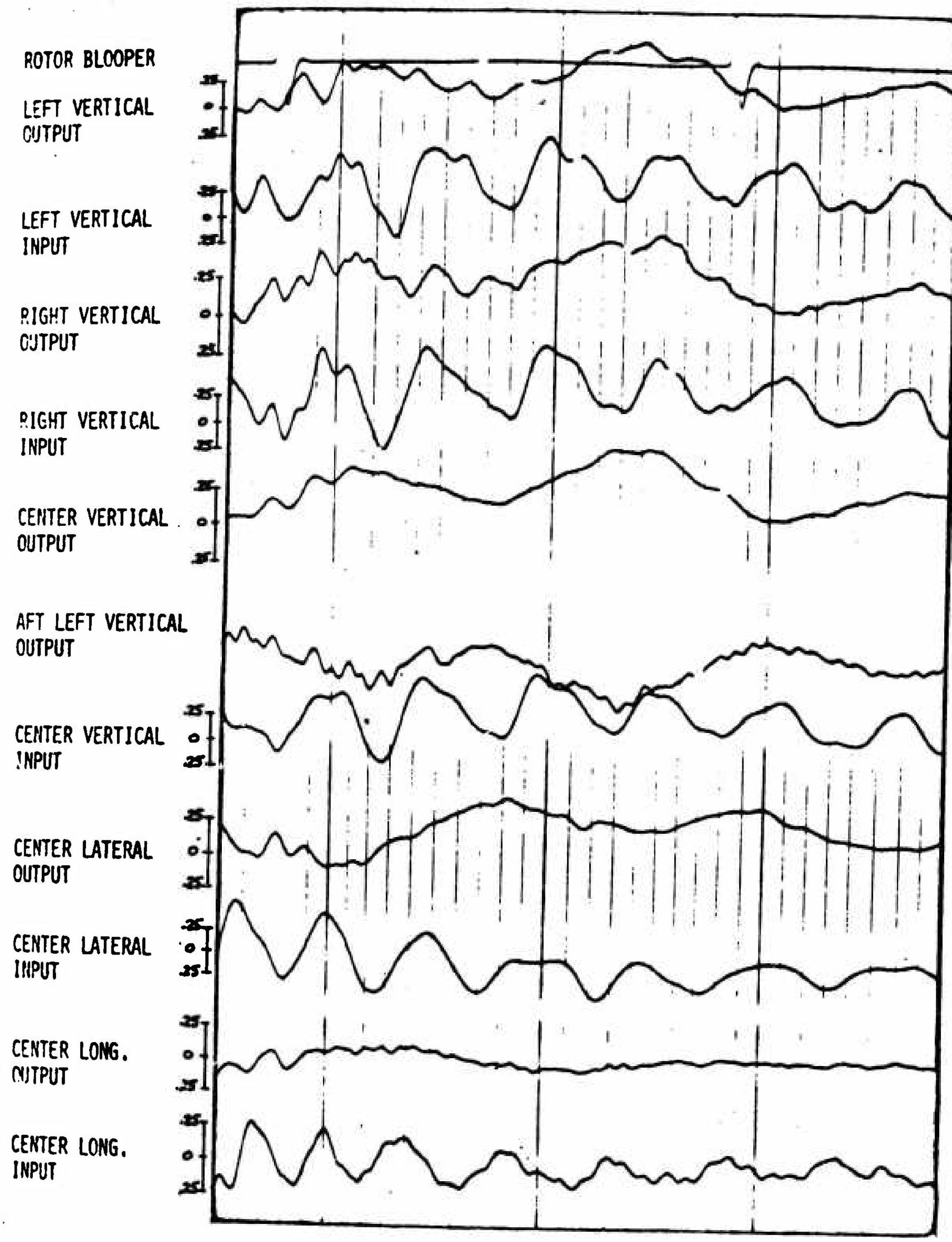


Figure 20. 200-Pound Three-Dimensional DAVI Platform Oscillograph Traces of the Landing Condition.

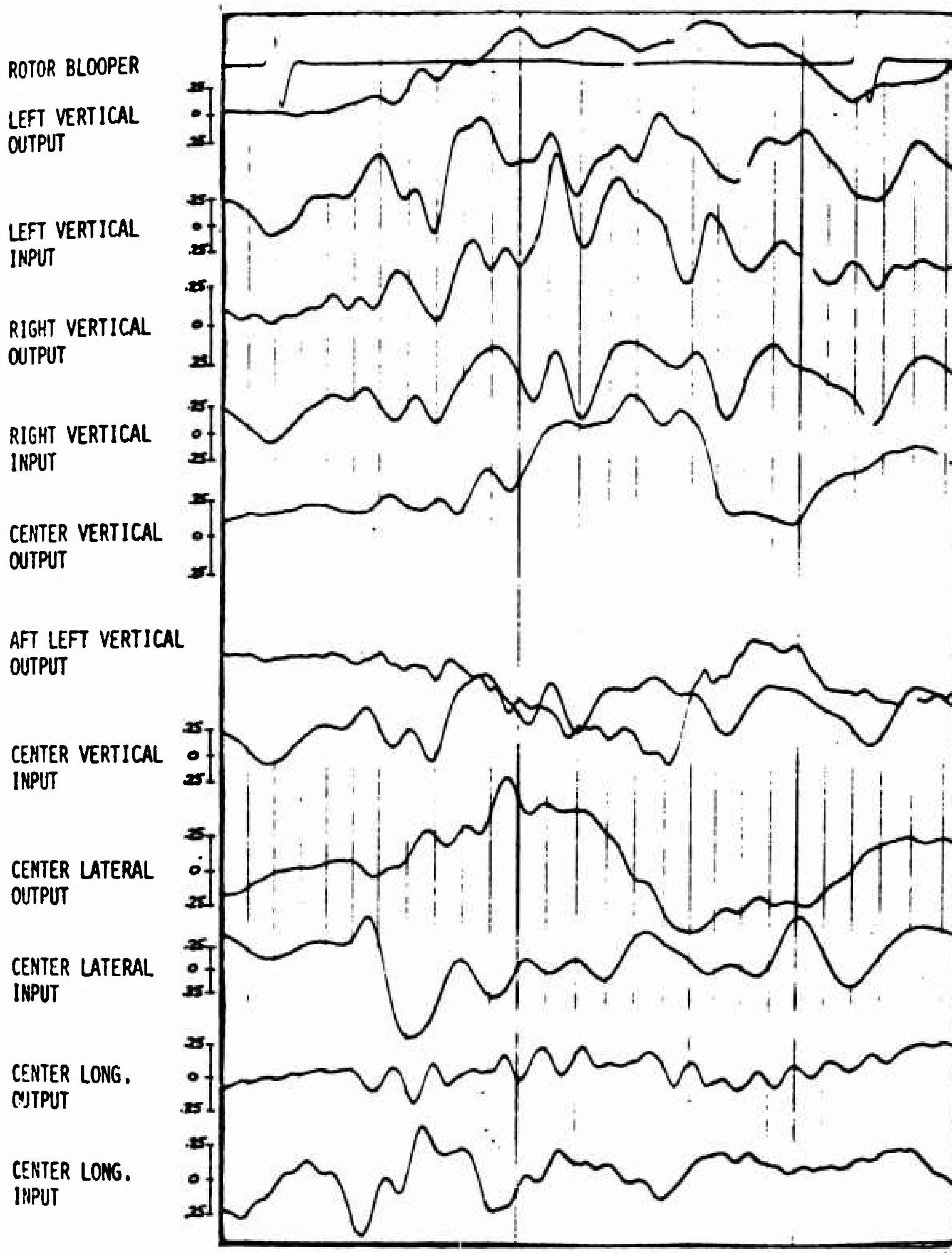


Figure 21. 200-Pound With a Three-Inch CG Offset Three-Dimensional DAVI Platform Oscillograph Traces of the Landing Condition.

TABLE III. FREQUENCIES OF THE PREDOMINANT HARMONICS OF THE UH-2C HELICOPTER

Main Rotor Speed (% rpm)	Frequencies of Predominant Harmonics (cps)		
	1	4	8
92	4.31	17.24	34.48
94	4.41	17.64	35.28
96	4.50	18.00	36.00
98	4.59	18.36	36.72
100	4.69	18.76	37.52
102	4.78	19.12	38.96
104	4.87	19.48	38.96
106	4.97	19.88	39.76

TABLE IV. PREDOMINANT VIBRATION LEVELS ON THE THREE-DIMENSIONAL ISOLATED PLATFORM

50-Pound Platform - 30 Knots

Main Rotor Speed (% rpm)	Pickup Location	Main Rotor Harmonic Vibration Level (±g) Unidirectional Inertia Bar Orientation: Lateral, One/Rev Input	Lateral, One/Rev Output	Lateral, Eight/Rev Input	Lateral, Eight/Rev Output	Longitudinal, One/Rev Input	Longitudinal, One/Rev Output	Longitudinal, Eight/Rev Input	Longitudinal, Eight/Rev Output
92	Lft Fwd Vt	.019	.017	.052	.028	.011	.011	.020	.013
	Rt Fwd Vt	.010	.007	.033	.017	.006	.001	.007	.005
	Center Vt	.017	.012	.033	.019	.004	.006	.017	.005
	Center Lat	.004	.003	.024	.017	.004	.005	.006	.007
	Center Long.	.016	.017	.010	.021	.022	.018	.014	.025
94	Lft Fwd Vt	.015	.014	.039	.026	.019	.016	.034	.009
	Rt Fwd Vt	.012	.011	.035	.021	.011	.006	.023	.018
	Center Vt	.025	.012	.042	.019	.007	.011	.027	.028
	Center Lat	.004	.005	.020	.011	.008	.004	.007	.012
	Center Long.	.011	.020	.031	.016	.018	.021	.021	.027
96	Lft Fwd Vt	.016	.017	.015	.016	.019	.015	.065	.016
	Rt Fwd Vt	.007	.010	.004	.009	.014	.010	.047	.040
	Center Vt	.020	.013	.011	.007	.014	.011	.045	.021
	Center Lat	.005	.006	.018	.010	.004	.007	.027	.021
	Center Long.	.013	.018	.009	.014	.013	.019	.014	.033
98	Lft Fwd Vt	.004	.008	.094	.045	.009	.006	.148	.044
	Rt Fwd Vt	.013	.010	.111	.058	.014	.011	.113	.064
	Center Vt	.011	.006	.098	.066	.008	.008	.127	.064
	Center Lat	.002	.006	.008	.012	.009	.009	.020	.018
	Center Long.	.013	.017	.041	.027	.021	.021	.065	.060
100	Lft Fwd Vt	.018	.023	.034	.018	.008	.005	.121	.032
	Rt Fwd Vt	.014	.014	.038	.014	.011	.007	.103	.048
	Center Vt	.012	.014	.027	.025	.012	.010	.112	.051
	Center Lat	.001	.006	.025	.011	.006	.006	.030	.013
	Center Long.	.012	.015	.023	.015	.008	.015	.060	.061
102	Lft Fwd Vt	.016	.020	.092	.042	.026	.030	.047	.011
	Rt Fwd Vt	.020	.017	.104	.039	.016	.017	.014	.004
	Center Vt	.021	.018	.086	.057	.018	.023	.025	.033
	Center Lat	.011	.008	.018	.022	.003	.006	.008	.005
	Center Long.	.018	.017	.028	.028	.021	.019	.035	.034
104	Lft Fwd Vt	.012	.016	.091	.044	.027	.021	.053	.013
	Rt Fwd Vt	.022	.014	.092	.043	.015	.013	.027	.013
	Center Vt	.012	.014	.084	.060	.023	.017	.031	.029
	Center Lat	.004	.006	.020	.029	.002	.006	.022	.015
	Center Long.	.026	.018	.063	.028	.019	.019	.032	.035

TABLE IV - Continued

Main Rotor Speed (% rpm)	Pickup Location	Lateral One/Rev Input	Lateral One/Rev Output	Lateral Eight/Rev Input	Lateral Eight/Rev Output	Longitudinal One/Rev Input	Longitudinal One/Rev Output	Longitudinal Eight/Rev Input	Longitudinal Eight/Rev Output
		Main Rotor Harmonic Vibration Level (±g)							
		Unidirectional Inertia Bar Orientation							
50-Pound Platform - 30 Knots									
106	Lft Fwd Vt	.026	.019	.169	.070	.021	.020	.022	.009
	Rt Fwd Vt	.007	.012	.200	.100	.014	.013	.021	.026
	Center Vt	.017	.012	.146	.092	.016	.014	.014	.027
	Center Lat	.014	.003	.015	.025	.007	.002	.014	.009
	Center Long.	.016	.013	.093	.050	.011	.016	.028	.034
50-Pound Platform - 120 Knots									
96	Lft Fwd Vt	.013	.017	.024	.019	.061	.070	.016	.011
	Rt Fwd Vt	.023	.021	.030	.017	.071	.067	.040	.017
	Center Vt	.017	.018	.022	.013	.063	.071	.024	.031
	Center Lat	.006	.008	.032	.036	.004	.010	.030	.020
	Center Long.	.010	.011	.034	.014	.023	.023	.048	.027
98	Lft Fwd Vt	.044	.048	.012	.026	.052	.058	.014	.008
	Rt Fwd Vt	.060	.057	.029	.024	.047	.041	.029	.025
	Center Vt	.048	.052	.013	.007	.043	.044	.015	.033
	Center Lat	.010	.005	.010	.006	.011	.013	.007	.012
	Center Long.	.029	.025	.027	.041	.017	.025	.022	.028
100	Lft Fwd Vt	.053	.059	.056	.042	.038	.041	.009	.005
	Rt Fwd Vt	.063	.060	.019	.060	.055	.050	.013	.009
	Center Vt	.051	.054	.007	.024	.048	.044	.010	.027
	Center Lat	.005	.015	.058	.066	.033	.017	.008	.008
	Center Long.	.022	.025	.026	.022	.032	.046	.031	.021
102	Lft Fwd Vt	.017	.025	.033	.014	.033	.041	.011	.010
	Rt Fwd Vt	.026	.022	.004	.023	.048	.050	.010	.006
	Center Vt	.019	.024	.015	.009	.040	.044	.035	.030
	Center Lat	.011	.014	.009	.021	.008	.003	.015	.014
	Center Long.	.018	.014	.047	.021	.015	.024	.033	.021
104	Lft Fwd Vt	.028	.036	.008	.017	.025	.028	.034	.010
	Rt Fwd Vt	.048	.047	.015	.017	.036	.034	.021	.015
	Center Vt	.034	.039	.005	.003	.033	.034	.025	.028
	Center Lat	.009	.015	.012	.012	.013	.017	.015	.006
	Center Long.	.028	.029	.047	.022	.015	.024	.029	.054
106	Lft Fwd Vt	.014	.014	.032	.019	.059	.064	.033	.020
	Rt Fwd Vt	.023	.022	.024	.020	.069	.072	.032	.027
	Center Vt	.016	.023	.024	.024	.063	.066	.028	.025
	Center Lat	.010	.080	.008	.013	.021	.021	.004	.003
	Center Long.	.028	.027	.013	.018	.021	.034	.058	.056

TABLE IV - Continued									
150-Pound Platform - 30 Knots									
		Main Rotor Harmonic Vibration Level (±g)							
		Unidirectional Inertia Bar Orientation							
		Lateral				Longitudinal			
Main Rotor Speed		One/Rev		Eight/Rev		One/Rev		Eight/Rev	
(% rpm)	Pickup Location	Input	Output	Input	Output	Input	Output	Input	Output
92	Lft Fwd Vt	.014	.023	.057	.013	.006	.007	.093	.033
	Rt Fwd Vt	.023	.025	.055	.016	.011	.014	.050	.047
	Center Vt	.019	.023	.053	.012	.007	.011	.067	.039
	Center Lat	.007	.004	.018	.007	.002	.004	.045	.026
	Center Long.	.010	.011	.013	.004	.007	.008	.025	.020
94	Lft Fwd Vt	.007	.013	.095	.009	.007	.014	.041	.020
	Rt Fwd Vt	.011	.020	.095	.031	.011	.017	.031	.049
	Center Vt	.013	.019	.093	.012	.008	.016	.048	.032
	Center Lat	.008	.002	.016	.008	.001	.003	.028	.017
	Center Long.	.008	.009	.033	.012	.007	.014	.017	.018
96	Lft Fwd Vt	.031	.040	.152	.038	.002	.007	.051	.031
	Rt Fwd Vt	.036	.042	.134	.029	.006	.010	.062	.063
	Center Vt	.030	.038	.135	.024	.005	.006	.059	.044
	Center Lat	.002	.005	.027	.008	.005	.006	.021	.006
	Center Long.	.006	.011	.049	.014	.006	.008	.0[illegible]4	.026
98	Lft Fwd Vt	.007	.011	.093	.047	.026	.028	.069	.060
	Rt Fwd Vt	.014	.013	.098	.045	.025	.029	.068	.081
	Center Vt	.009	.012	.090	.020	.025	.030	.063	.058
	Center Lat	.007	.001	.022	.013	.007	.005	.011	.005
	Center Long.	.013	.010	.050	.016	.004	.011	.038	.027
100	Lft Fwd Vt	.006	.011	.066	.031	.011	.015	.082	.049
	Rt Fwd Vt	.011	.011	.059	.026	.015	.021	.067	.055
	Center Vt	.007	.012	.055	.007	.020	.013	.067	.043
	Center Lat	.005	.006	.008	.004	.005	.005	.024	.013
	Center Long.	.010	.011	.019	.019	.011	.015	.027	.024
102	Lft Fwd Vt	.012	.023	.065	.060	.019	.024	.081	.038
	Rt Fwd Vt	.016	.022	.097	.048	.016	.019	.047	.050
	Center Vt	.018	.022	.079	.007	.015	.022	.056	.037
	Center Lat	.007	.005	.027	.029	.005	.004	.008	.010
	Center Long.	.005	.013	.066	.025	.011	.008	.021	.016
104	Lft Fwd Vt	.020	.030	.078	.104	.019	.026	.067	.062
	Rt Fwd Vt	.024	.032	.123	.077	.018	.018	.042	.072
	Center Vt	.021	.029	.090	.003	.016	.021	.045	.067
	Center Lat	.004	.006	.033	.031	.006	.001	.027	.008
	Center Long.	.009	.014	.089	.037	.010	.012	.043	.021

TABLE IV - Continued									
150-Pound Platform - 30 Knots									
		Main Rotor Harmonic Vibration Level (±g)							
		Unidirectional Inertia Bar Orientation							
		Lateral				Longitudinal			
		One/Rev		Eight/Rev		One/Rev		Eight/Rev	
Main Rotor Speed (% rpm)	Pickup Location	Input	Output	Input	Output	Input	Output	Input	Output
106	Lft Fwd Vt	.030	.038	.085	.064	.022	.029	.112	.124
	Rt Fwd Vt	.026	.034	.086	.058	.019	.023	.082	.126
	Center Vt	.026	.036	.062	.008	.022	.031	.070	.113
	Center Lat	.005	.010	.022	.025	.005	.005	.011	.007
	Center Long.	.010	.018	.082	.032	.016	.018	.060	.034
150-Pound Platform - 120 Knots									
96	Lft Fwd Vt	.024	.037	.040	.018	.040	.048	.019	.039
	Rt Fwd Vt	.034	.038	.055	.016	.053	.059	.042	.052
	Center Vt	.023	.034	.032	.007	.041	.053	.030	.048
	Center Lat	.008	.005	.025	.016	.006	.004	.025	.010
	Center Long.	.018	.026	.061	.022	.023	.021	.055	.026
98	Lft Fwd Vt	.026	.040	.022	.020	.044	.062	.009	.024
	Rt Fwd Vt	.032	.046	.042	.015	.059	.069	.030	.047
	Center Vt	.022	.043	.018	.009	.048	.064	.014	.045
	Center Lat	.011	.013	.008	.008	.008	.009	.029	.015
	Center Long.	.018	.029	.029	.018	.026	.028	.046	.024
100	Lft Fwd Vt	.005	.019	.018	.056	.034	.048	.015	.029
	Rt Fwd Vt	.012	.022	.038	.027	.062	.051	.007	.041
	Center Vt	.011	.020	.021	.019	.054	.040	.007	.040
	Center Lat	.006	.015	.032	.014	.001	.010	.021	.013
	Center Long.	.025	.027	.053	.015	.042	.029	.025	.016
102	Lft Fwd Vt	.037	.049	.021	.026	.061	.094	.036	.052
	Rt Fwd Vt	.046	.053	.015	.011	.078	.091	.022	.073
	Center Vt	.038	.055	.004	.017	.060	.091	.022	.059
	Center Lat	.007	.003	.027	.009	.010	.018	.008	.009
	Center Long.	.028	.036	.039	.004	.021	.025	.051	.023
104	Lft Fwd Vt	.020	.038	.026	.018	.021	.026	.058	.055
	Rt Fwd Vt	.040	.044	.039	.017	.025	.037	.042	.066
	Center Vt	.029	.038	.021	.007	.021	.031	.040	.055
	Center Lat	.005	.010	.003	.003	.005	.004	.006	.010
	Center Long.	.022	.022	.054	.015	.026	.030	.068	.022
106	Lft Fwd Vt	.025	.035	.029	.014	.033	.036	.035	.018
	Rt Fwd Vt	.036	.036	.025	.004	.019	.012	.026	.023
	Center Vt	.023	.024	.027	.006	.024	.022	.030	.043
	Center Lat	.005	.014	.011	.010	.015	.011	.018	.007
	Center Long.	.010	.019	.038	.014	.029	.037	.041	.010

TABLE IV - Continued									
200-Pound Platform - 30 Knots									
		Main Rotor Harmonic Vibration Level (±g)							
		Unidirectional Inertia Bar Orientation							
		Lateral				Longitudinal			
Main Rotor Speed (% rpm)	Pickup Location	One/Rev		Eight/Rev		One/Rev		Eight/Rev	
		Input	Output	Input	Output	Input	Output	Input	Output
92	Lft Fwd Vt	.049	.072	.017	.015	.011	.019	.058	.041
	Rt Fwd Vt	.040	.056	.021	.016	.011	.016	.024	.048
	Center Vt	.041	.058	.015	.002	.011	.018	.044	.046
	Center Lat	.013	.004	.011	.007	.003	.005	.019	.007
	Center Long.	.032	.035	.015	.006	.020	.020	.024	.028
94	Lft Fwd Vt	.041	.054	.011	.017	.009	.010	.035	.039
	Rt Fwd Vt	.026	.036	.019	.016	.003	.005	.039	.044
	Center Vt	.029	.044	.011	.006	.008	.007	.034	.043
	Center Lat	.008	.010	.007	.011	.005	.004	.017	.004
	Center Long.	.030	.044	.012	.014	.010	.022	.008	.020
96	Lft Fwd Vt	.033	.050	.041	.019	.011	.018	.033	.017
	Rt Fwd Vt	.020	.028	.040	.028	.014	.016	.030	.013
	Center Vt	.031	.036	.031	.005	.010	.011	.024	.018
	Center Lat	.011	.012	.006	.011	-	.003	.027	.002
	Center Long.	.035	.047	.020	.012	.014	.021	.012	.006
98	Lft Fwd Vt	.039	.058	.095	.045	.012	.009	.021	.014
	Rt Fwd Vt	.025	.034	.072	.036	.004	.002	.005	.012
	Center Vt	.025	.051	.079	.006	.006	.006	.013	.017
	Center Lat	.008	.007	.025	.004	.003	.003	.003	.002
	Center Long.	.026	.049	.024	.008	.021	.017	.014	.005
100	Lft Fwd Vt	.048	.067	.062	.026	.017	.019	.152	.084
	Rt Fwd Vt	.032	.050	.043	.023	.008	.014	.114	.092
	Center Vt	.039	.058	.042	.010	.004	.011	.116	.092
	Center Lat	.018	.008	.026	.002	.007	.004	.012	.005
	Center Long.	.032	.040	.043	.013	.015	.029	.081	.039
102	Lft Fwd Vt	.051	.080	.071	.033	.022	.025	.106	.092
	Rt Fwd Vt	.045	.060	.050	.039	.014	.017	.112	.083
	Center Vt	.070	.041	.049	.010	.017	.020	.104	.100
	Center Lat	.007	.009	.019	.005	.004	.005	.031	.006
104	Lft Fwd Vt	.012	.024	.016	.021	.029	.050	.062	.049
	Rt Fwd Vt	.006	.010	.038	.026	.018	.039	.074	.053
	Center Vt	.010	.018	.020	.012	.023	.046	.050	.057
	Center Lat	.015	.008	.030	.007	.007	.003	.023	.006
	Center Long.	.030	.031	.064	.024	.016	.027	.052	.023

TABLE IV - Continued

Main Rotor Speed (% rpm)	Pickup Location	Main Rotor Harmonic Vibration Level (±g)							
		Unidirectional Inertia Bar Orientation							
		Lateral				Longitudinal			
		One/Rev		Eight/Rev		One/Rev		Eight/Rev	
		Input	Output	Input	Output	Input	Output	Input	Output
200-Pound Platform - 30 Knots									
106	Lft Fwd Vt	.036	.048	.066	.056	.031	.049	.063	.046
	Rt Fwd Vt	.017	.033	.151	.051	.018	.032	.044	.054
	Center Vt	.030	.036	.079	.016	.020	.037	.025	.059
	Center Lat	.016	.014	.043	.020	.013	.009	.007	.006
	Center Long.	.031	.031	.098	.027	.022	.031	.054	.014
200-Pound Platform - 120 Knots									
96	Lft Fwd Vt	.021	.031	.012	.018	.009	.026	.022	.036
	Rt Fwd Vt	.013	.025	.049	.019	.016	.035	.037	.036
	Center Vt	.016	.015	.021	.018	.014	.026	.029	.053
	Center Lat	.011	.006	.031	.008	.001	.009	.017	.008
	Center Long.	.021	.033	.050	.015	.011	.008	.045	.020
98	Lft Fwd Vt	.020	.042	.018	.026	.035	.043	.009	.012
	Rt Fwd Vt	.025	.049	.021	.028	.048	.055	.018	.013
	Center Vt	.025	.047	.009	.008	.039	.051	.014	.014
	Center Lat	.004	.018	.029	.008	.008	.008	.021	.005
	Center Long.	.017	.029	.008	.007	.020	.028	.022	.001
100	Lft Fwd Vt	.015	.016	.030	.035	.033	.045	.012	.025
	Rt Fwd Vt	.023	.020	.015	.019	.046	.060	.009	.023
	Center Vt	.012	.009	.017	.012	.032	.057	.003	.029
	Center Lat	.004	.011	.009	.006	.009	.012	.012	.005
	Center Long.	.022	.013	.036	.013	.028	.042	.022	.009
102	Lft Fwd Vt	.022	.025	.030	.012	.038	.065	.042	.032
	Rt Fwd Vt	.030	.034	.018	.002	.054	.075	.019	.033
	Center Vt	.025	.037	.012	.008	.043	.073	.021	.043
	Center Lat	.014	.012	.010	.002	.004	.012	.027	.007
	Center Long.	.015	.031	.031	.011	.024	.042	.051	.014
104	Lft Fwd Vt	.009	.010	.036	.008	.076	.096	.019	.031
	Rt Fwd Vt	.027	.030	.016	.008	.091	.107	.008	.036
	Center Vt	.018	.022	.024	.010	.079	.104	.008	.034
	Center Lat	.010	.015	.019	.004	.017	.009	.013	.007
	Center Long.	.019	.031	.047	.012	.031	.045	.032	.011
106	Lft Fwd Vt	.022	.035	.054	.026	.022	.037	.049	.029
	Rt Fwd Vt	.036	.040	.056	.014	.044	.052	.033	.045
	Center Vt	.021	.033	.043	.004	.032	.046	.031	.040
	Center Lat	.004	.001	.011	.007	.013	.012	.007	.007
	Center Long.	.017	.030	.036	.010	.026	.040	.063	.010

TABLE IV - Continued									
200-Pound Platform With 3-Inch CG Offset - 30 Knots									
		Main Rotor Harmonic Vibration Level (±g)							
		Unidirectional Inertia Bar Orientation							
		Lateral				Longitudinal			
Main Rotor Speed		One/Rev		Eight/Rev		One/Rev		Eight/Rev	
(% rpm)	Pickup Location	Input	Output	Input	Output	Input	Output	Input	Output
92	Lft Fwd Vt	.014	.015	.094	.016	.005	.025	.096	.027
	Rt Fwd Vt	.006	.012	.031	.048	.012	.014	.047	.028
	Center Vt	.010	.015	.061	.031	.014	.021	.084	.023
	Center Lat	.008	.003	.058	.018	.005	.009	.047	.015
	Center Long.	.009	.010	.037	.008	.021	.028	.025	.019
94	Lft Fwd Vt	.012	.020	.070	.007	.018	.025	.052	.035
	Rt Fwd Vt	.010	.013	.036	.032	.017	.022	.024	.029
	Center Vt	.012	.017	.040	.023	.014	.025	.042	.023
	Center Lat	.004	.006	.018	.011	.006	.005	.029	.009
	Center Long.	.012	.017	.023	.012	.019	.025	.033	.018
96	Lft Fwd Vt	.004	.014	.034	.007	.013	.028	.146	.075
	Rt Fwd Vt	.009	.010	.035	.011	.026	.026	.115	.059
	Center Vt	.004	.012	.025	.004	.024	.030	.124	.055
	Center Lat	.008	.009	.012	.005	.012	.005	.013	.007
	Center Long.	.008	.012	.017	.004	.021	.028	.064	.034
98	Lft Fwd Vt	.006	.003	.015	.004	.028	.057	.105	.049
	Rt Fwd Vt	.003	.001	.021	.010	.034	.041	.063	.046
	Center Vt	.003	.004	.012	.005	.029	.052	.089	.036
	Center Lat	.002	.002	.008	.008	.005	.005	.022	.014
	Center Long.	.009	.010	.015	.007	.020	.023	.035	.021
100	Lft Fwd Vt	.019	.030	.091	.009	.033	.062	.104	.069
	Rt Fwd Vt	.023	.026	.067	.026	.026	.036	.058	.055
	Center Vt	.019	.029	.072	.014	.025	.050	.078	.054
	Center Lat	.006	.005	.029	.003	.007	.006	.031	.009
	Center Long.	.004	.009	.021	.010	.023	.028	.053	.033
102	Lft Fwd Vt	.022	.038	.119	.002	.021	.031	.057	.084
	Rt Fwd Vt	.023	.031	.045	.016	.015	.024	.076	.049
	Center Vt	.025	.033	.068	.027	.016	.031	.070	.065
	Center Lat	.006	.009	.023	.005	.011	.009	.029	.002
	Center Long.	.010	.015	.046	.018	.024	.038	.061	.032
104	Lft Fwd Vt	.020	.029	.039	.009	.028	.040	.045	.045
	Rt Fwd Vt	.017	.020	.005	.013	.018	.020	.023	.031
	Center Vt	.015	.021	.014	.014	.017	.024	.023	.042
	Center Lat	.006	.005	.024	.007	.011	.008	.015	.008
	Center Long.	.007	.016	.032	.015	.029	.043	.043	.010

TABLE IV - Continued

200-Pound Platform With 3-Inch CG Offset - 30 Knots

Main Rotor Speed (% rpm)	Pickup Location	Lateral One/Rev Input	Lateral One/Rev Output	Lateral Eight/Rev Input	Lateral Eight/Rev Output	Longitudinal One/Rev Input	Longitudinal One/Rev Output	Longitudinal Eight/Rev Input	Longitudinal Eight/Rev Output
		Main Rotor Harmonic Vibration Level (±g)							
		Unidirectional Inertia Bar Orientation							
106	Lft Fwd Vt	.007	.011	.059	.020	.029	.053	.005	.031
	Rt Fwd Vt	.008	.005	.095	.040	.014	.023	.017	.012
	Center Vt	.003	.003	.060	.007	.023	.030	.017	.021
	Center Lat	.006	.008	.025	.014	.007	.015	.016	.003
	Center Long.	.021	.012	.065	.021	.033	.046	.032	.008
200-Pound Platform With 3-Inch CG Offset - 120 Knots									
96	Lft Fwd Vt	.050	.059	.024	.022	.025	.042	.029	.058
	Rt Fwd Vt	.052	.052	.058	.013	.036	.046	.046	.028
	Center Vt	.043	.049	.030	.021	.025	.043	.021	.050
	Center Lat	.006	.005	.028	.003	.014	.004	.029	.008
	Center Long.	.022	.015	.066	.011	.024	.024	.056	.021
98	Lft Fwd Vt	.012	.008	.009	.005	.028	.044	.043	.038
	Rt Fwd Vt	.020	.017	.056	.018	.039	.050	.051	.019
	Center Vt	.015	.013	.026	.020	.033	.047	.038	.040
	Center Lat	.001	.008	.030	.005	.007	.010	.024	.008
	Center Long.	.019	.031	.032	.013	.029	.038	.030	.018
100	Lft Fwd Vt	.010	.014	.025	.004	.030	.046	.021	.040
	Rt Fwd Vt	.011	.009	.064	.022	.038	.033	.010	.014
	Center Vt	.003	.006	.030	.026	.032	.037	.004	.032
	Center Lat	.009	.011	.028	.004	.002	.023	.040	.008
	Center Long.	.021	.017	.033	.010	.033	.061	.046	.014
102	Lft Fwd Vt	.018	.014	.095	.005	.052	.080	.026	.023
	Rt Fwd Vt	.012	.014	.034	.010	.071	.080	.016	.023
	Center Vt	.014	.020	.025	.006	.056	.082	.019	.018
	Center Lat	.007	.016	.010	.004	.003	.007	.010	.008
	Center Long.	.029	.041	.030	.008	.026	.041	.045	.011
104	Lft Fwd Vt	.017	.030	.049	.011	.035	.065	.021	.032
	Rt Fwd Vt	.022	.027	.061	.020	.040	.048	.014	.020
	Center Vt	.017	.026	.041	.008	.024	.046	.012	.027
	Center Lat	.007	.003	.008	.007	.007	.011	.019	.007
	Center Long.	.009	.014	.038	.009	.045	.071	.043	.011
106	Lft Fwd Vt	.047	.068	.033	.011	.013	.041	.063	.022
	Rt Fwd Vt	.046	.055	.051	.014	.025	.029	.048	.032
	Center Vt	.035	.052	.047	.012	.016	.035	.042	.027
	Center Lat	.003	.005	.015	.002	.011	.002	.023	.008
	Center Long.	.006	.011	.049	.020	.025	.034	.059	.011

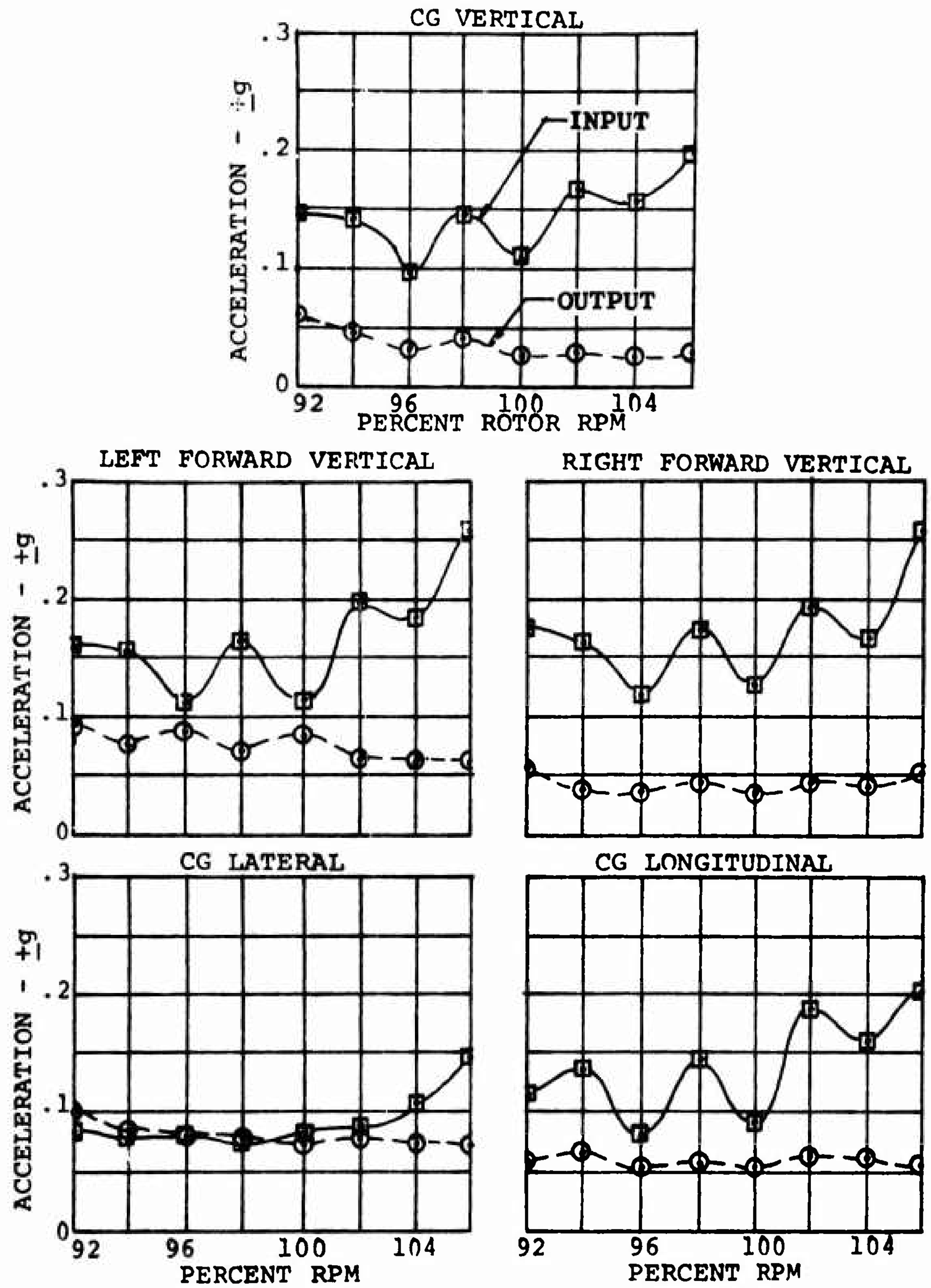


Figure 22. 30-Knot Four-Per-Rev Results of the 50-Pound Platform With Laterally Oriented Three-Dimensional DAVI's.

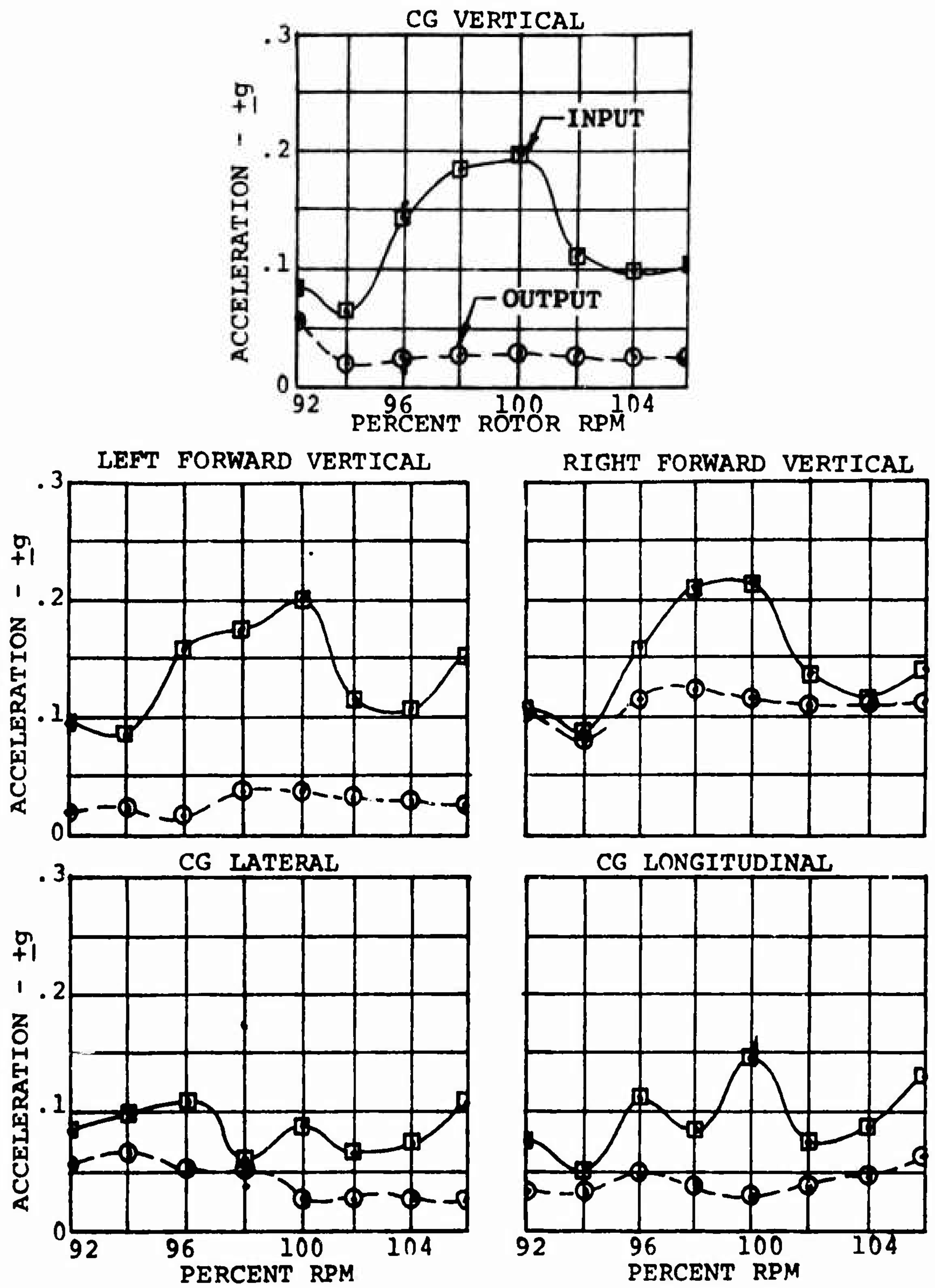


Figure 23. 30-Knot Four-Per-Rev Results of the 50-Pound Platform With Longitudinally Oriented Three-Dimensional DAVI's.

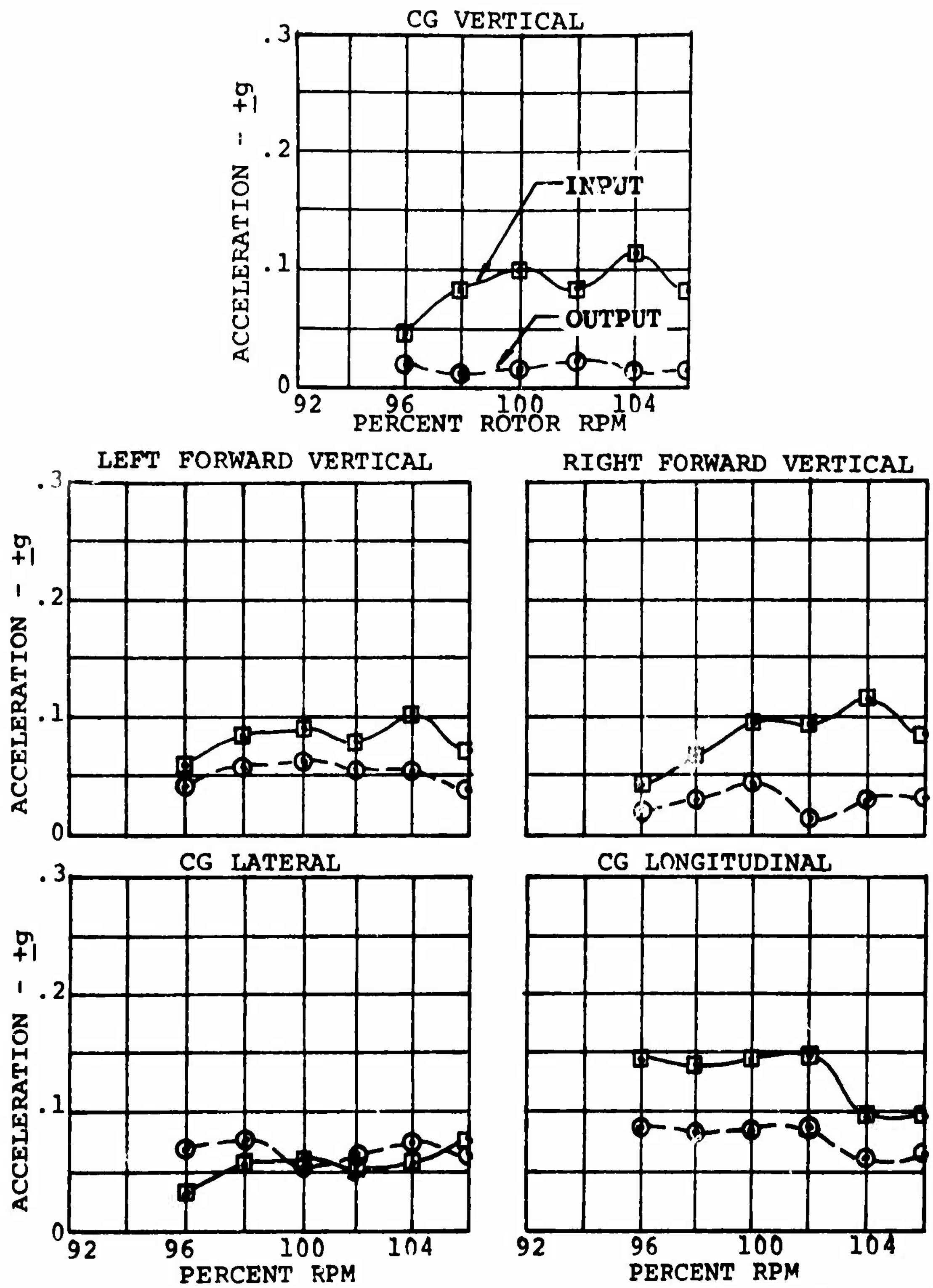


Figure 24. 120-Knot Four-Per-Rev Results of the 50-Pound Platform With Laterally Oriented Three-Dimensional DAVI's.

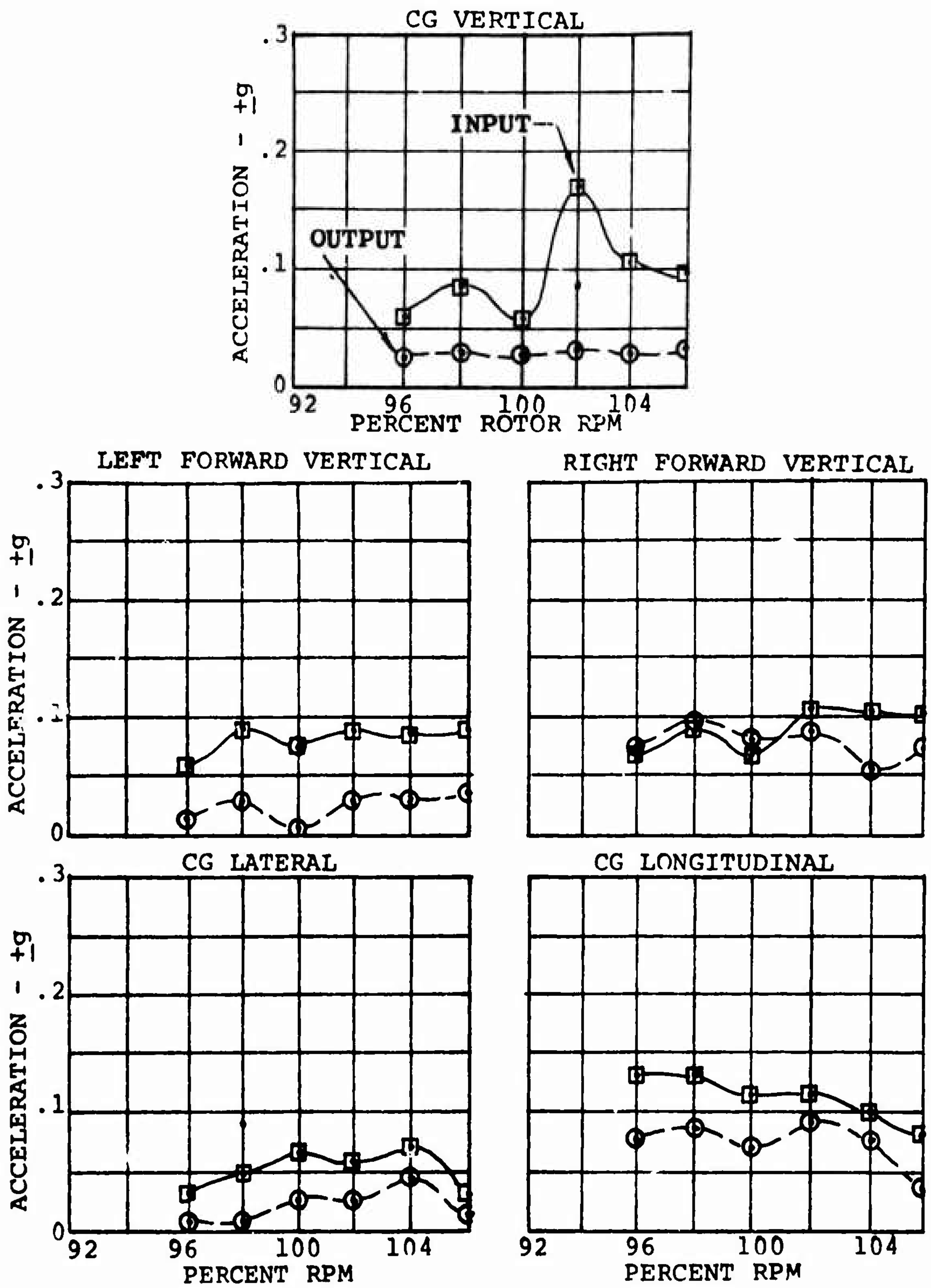


Figure 25. 120-Knot Four-Per-Rev Results of the 50-Pound Platform With Longitudinally Oriented Three-Dimensional DAVI's.

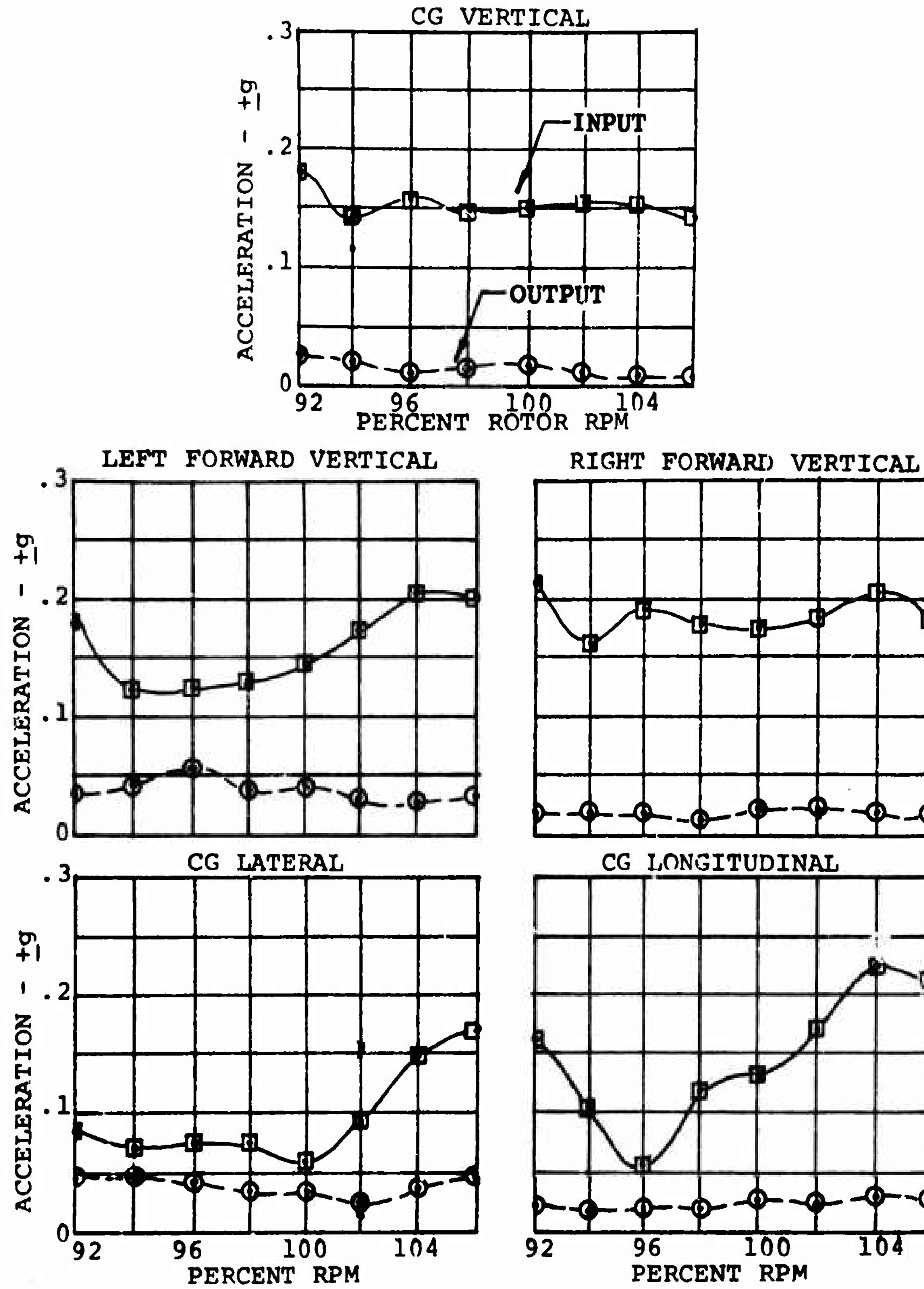


Figure 26. 30-Knot Four-Per-Rev Results of the 150-Pound Platform With Laterally Oriented Three-Dimensional DAVI's.

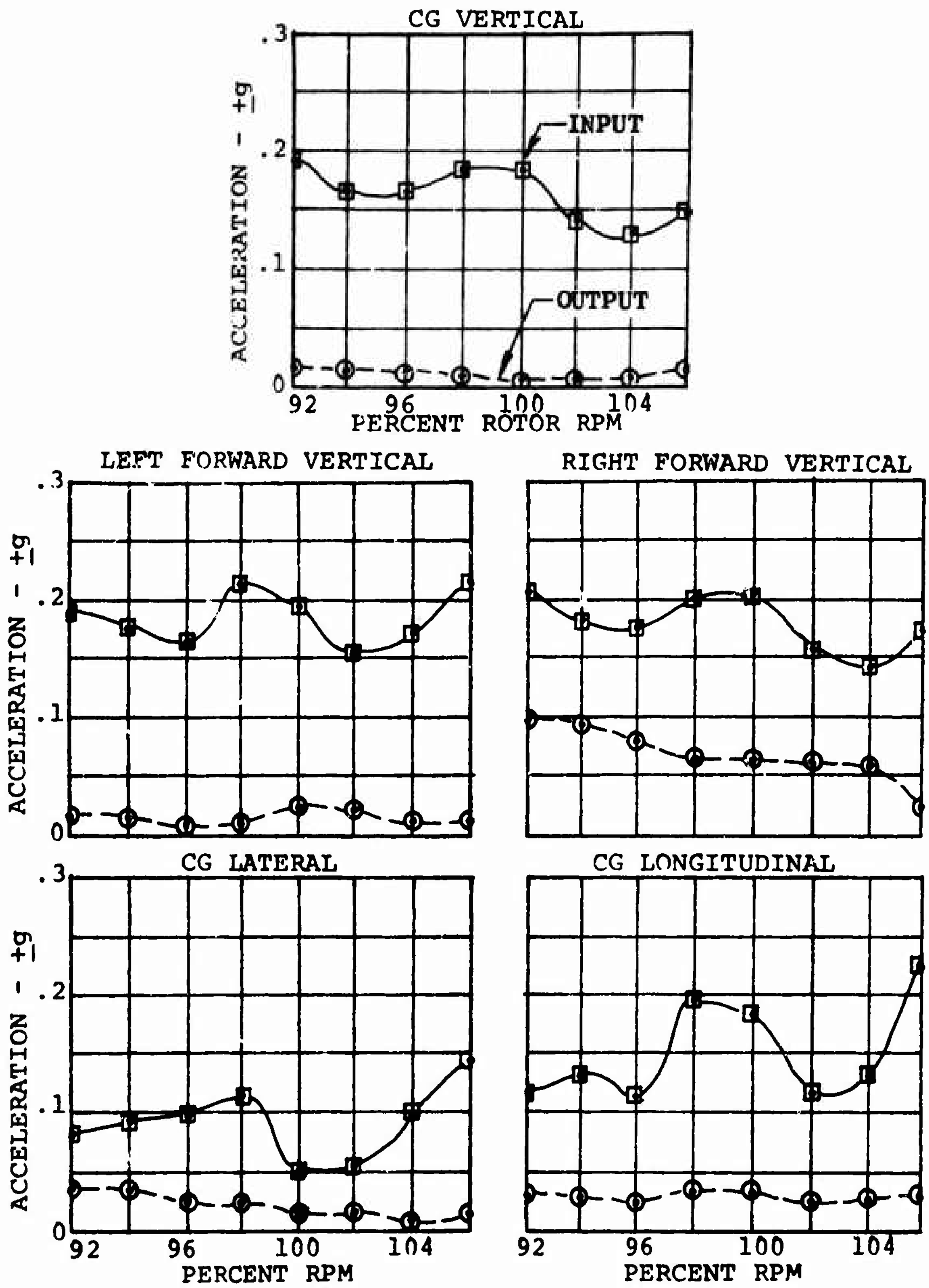


Figure 27. 30-Knot Four-Per-Rev Results of the 150-Pound Platform With Longitudinally Oriented Three-Dimensional DAVI's.

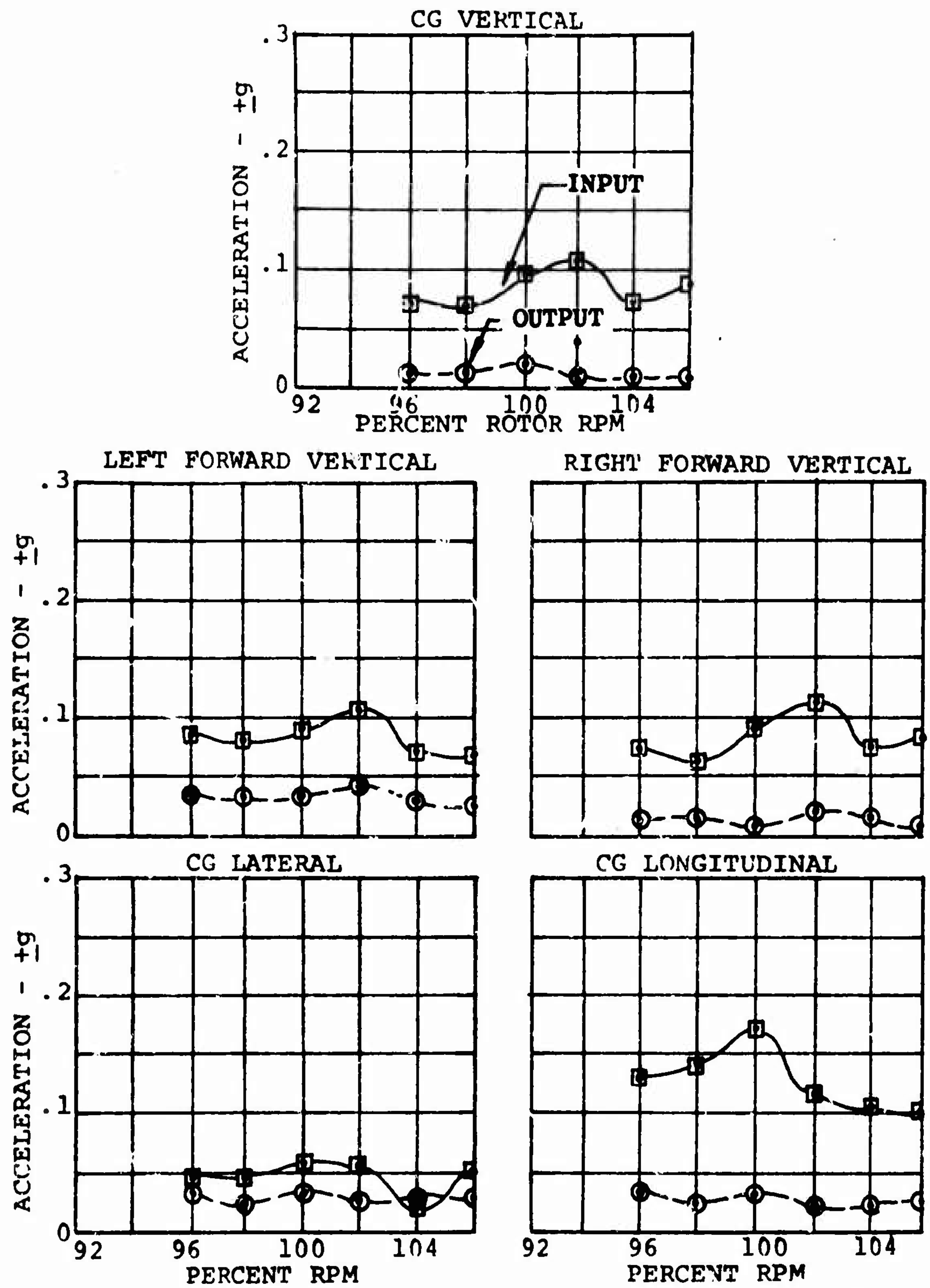


Figure 28. 120-Knot Four-Per-Rev Results of the 150-Pound Platform With Laterally Oriented Three-Dimensional DAVI's.

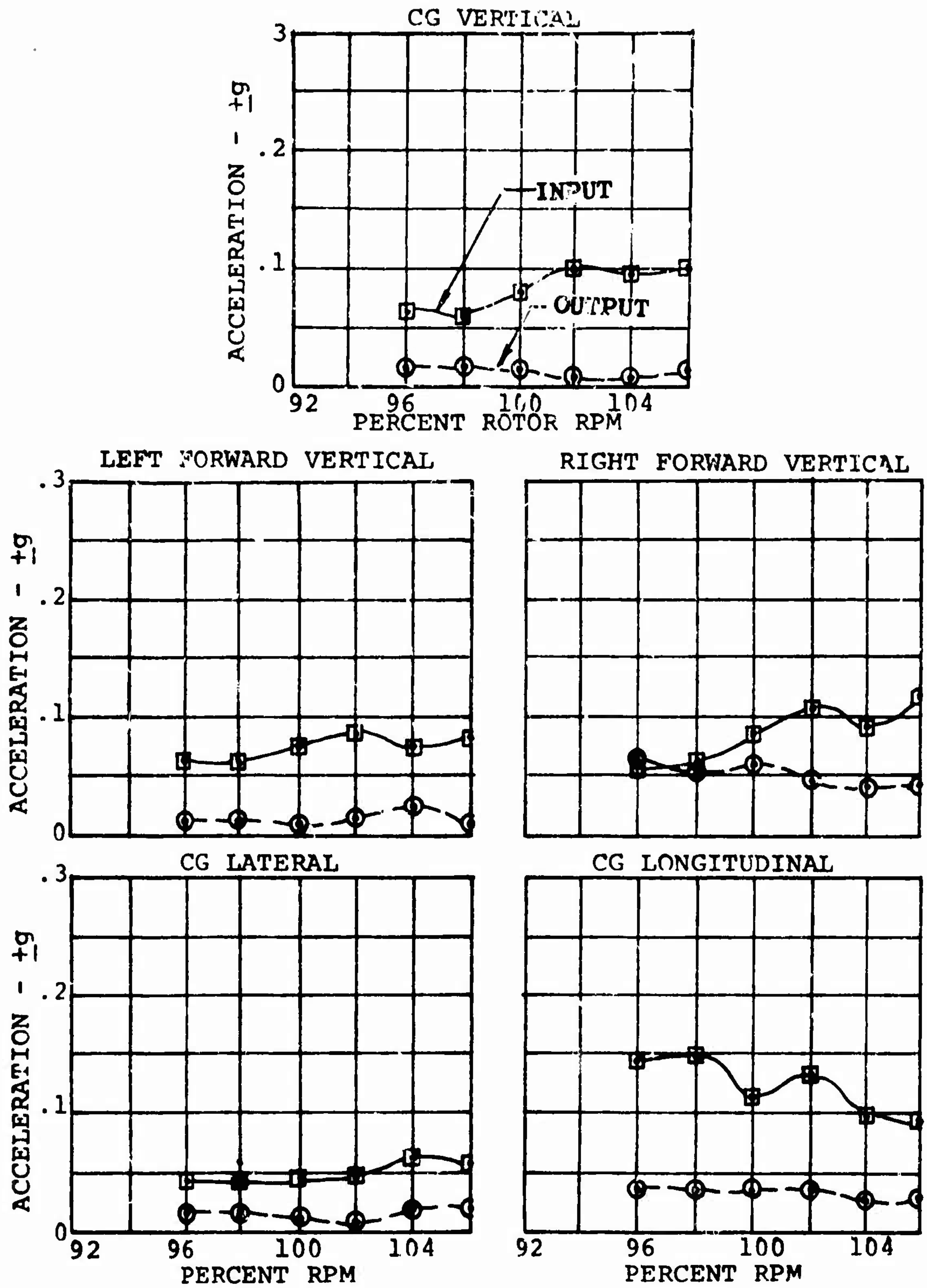


Figure 29. 120-Knot Four-Per-Rev Results of the 150-Pound Platform With Longitudinally Oriented Three-Dimensional DAVI's.

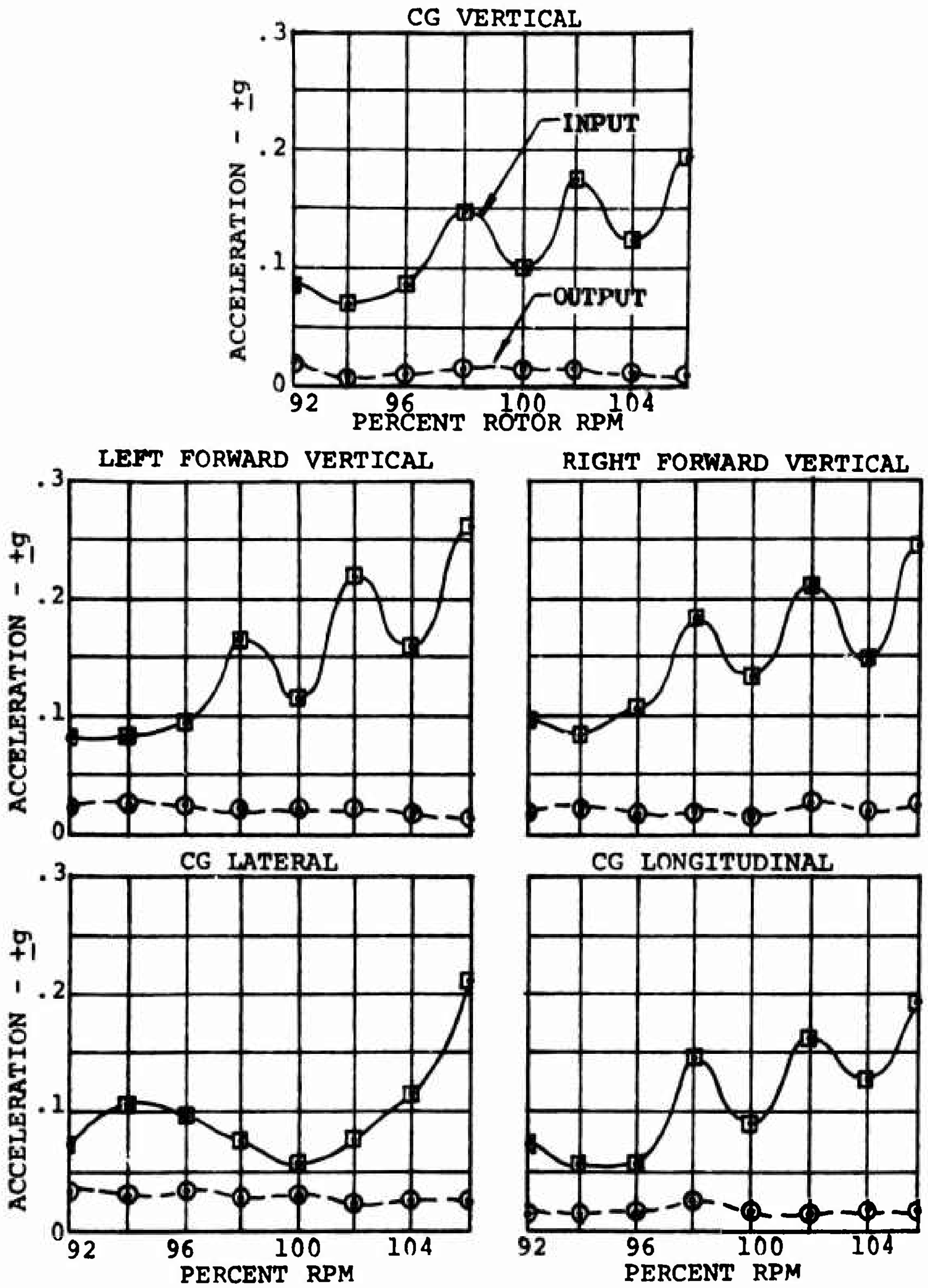


Figure 30. 30-Knot Four-Per-Rev Results of the 200-Pound Platform With Laterally Oriented Three-Dimensional DAVI's.

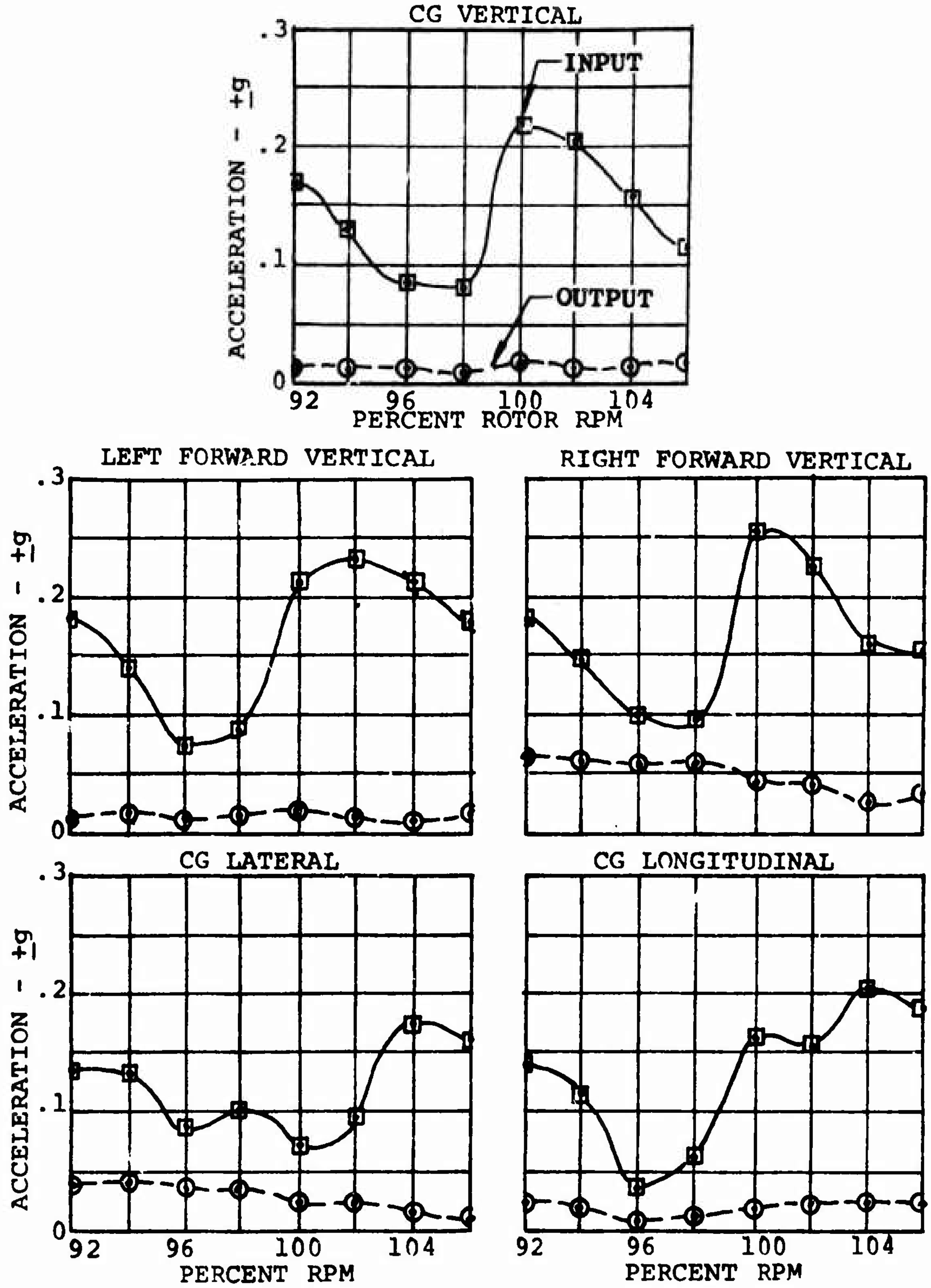


Figure 31. 30-Knot Four-Per-Rev Results of the 200-Pound Platform With Longitudinally Oriented Three-Dimensional DAVI's.

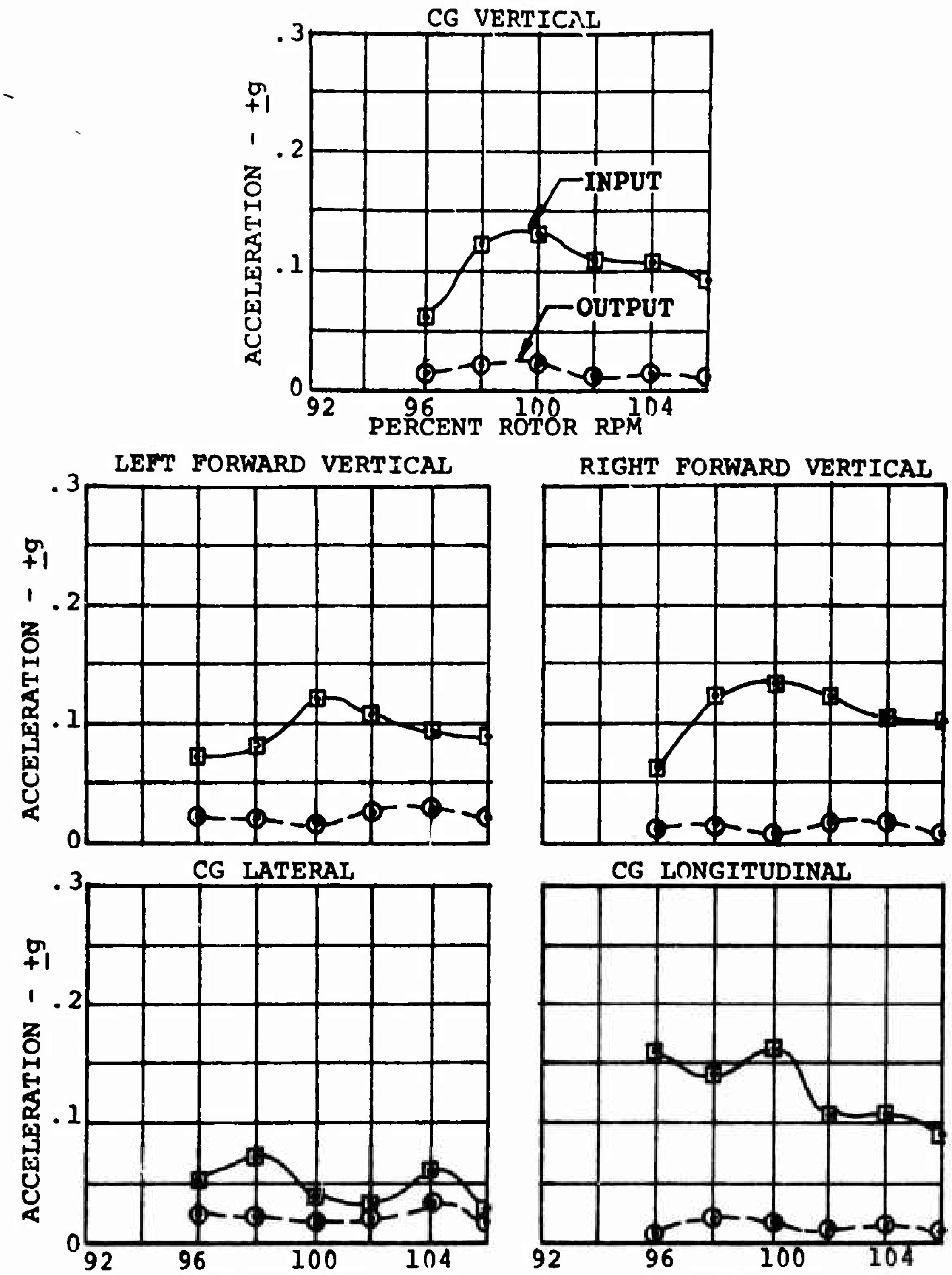


Figure 32. 120-Knot Four-Per-Rev Results of the 200-Pound Platform With Laterally Oriented Three-Dimensional DAVI's.

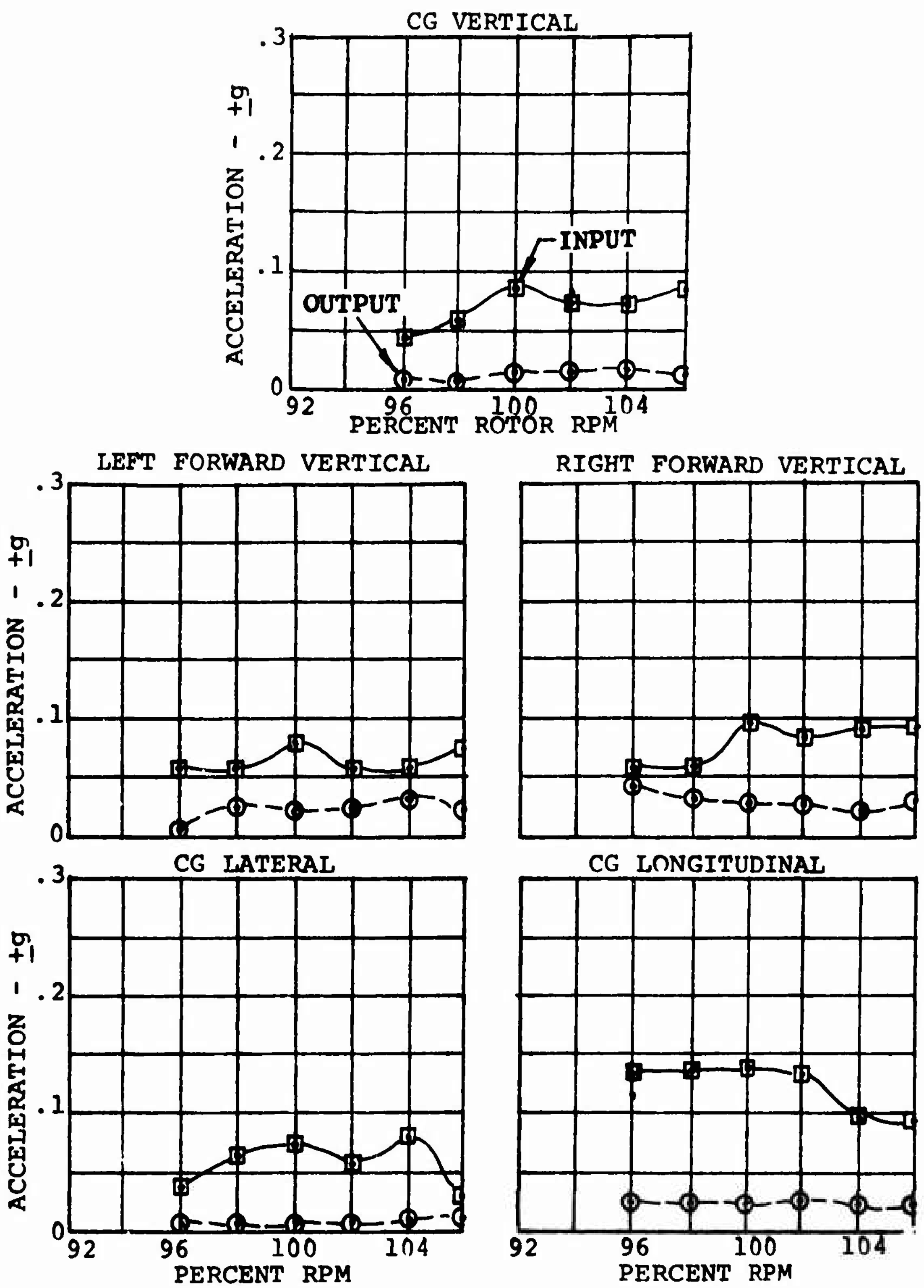


Figure 33. 120-Knot Four-Per-Rev Results of the 200-Pound Platform With Longitudinally Oriented Three-Dimensional DAVI's.

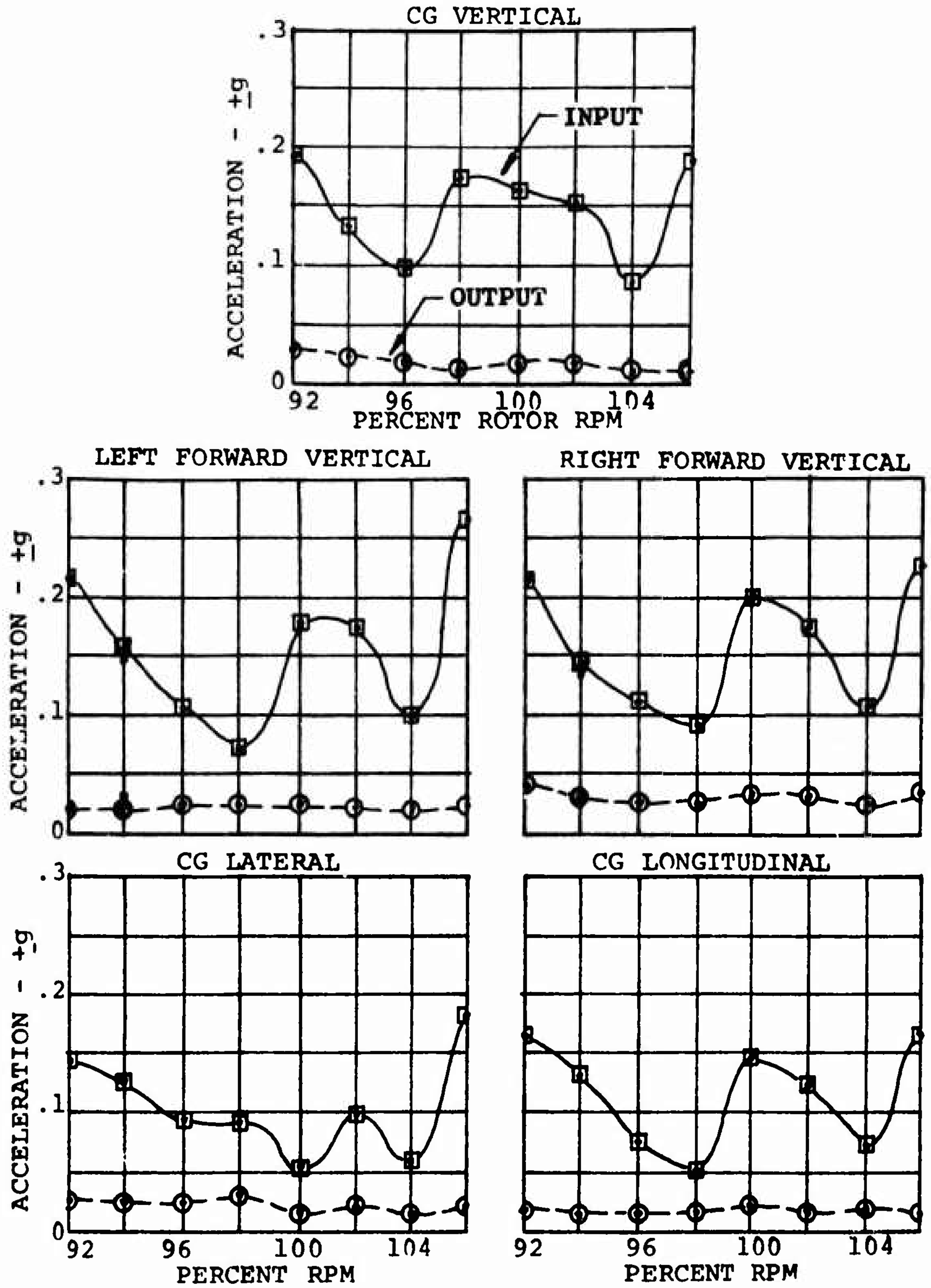


Figure 34. 30-Knot Four-Per-Rev Results of a 200-Pound With a Three-Inch Offset CG Platform With Laterally Oriented Three-Dimensional DAVI's.

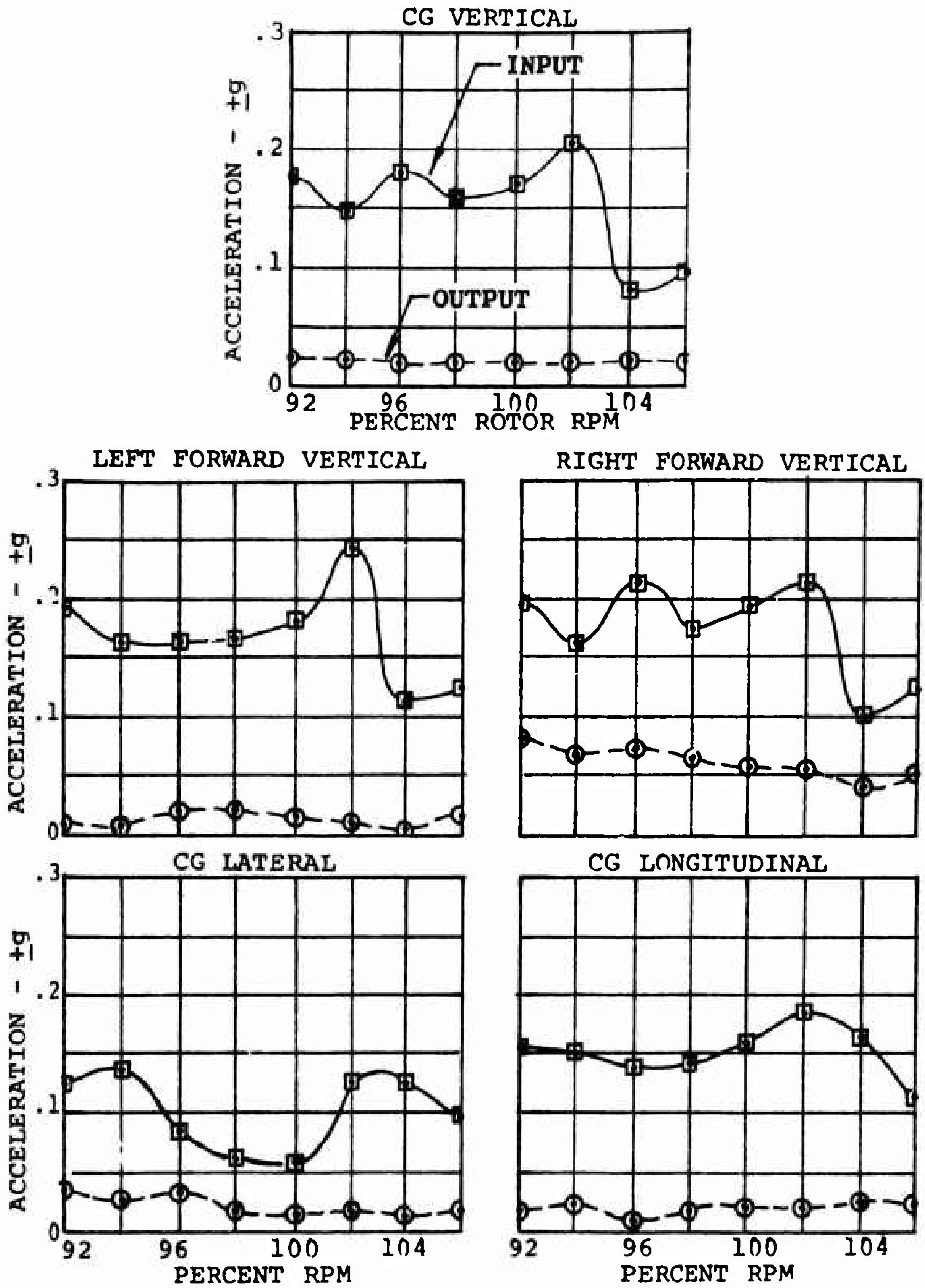


Figure 35. 30-Knot Four-Per-Rev Results of the 200-Pound With a Three-Inch Offset CG Platform With Longitudinally Oriented Three-Dimensional DAVI's.

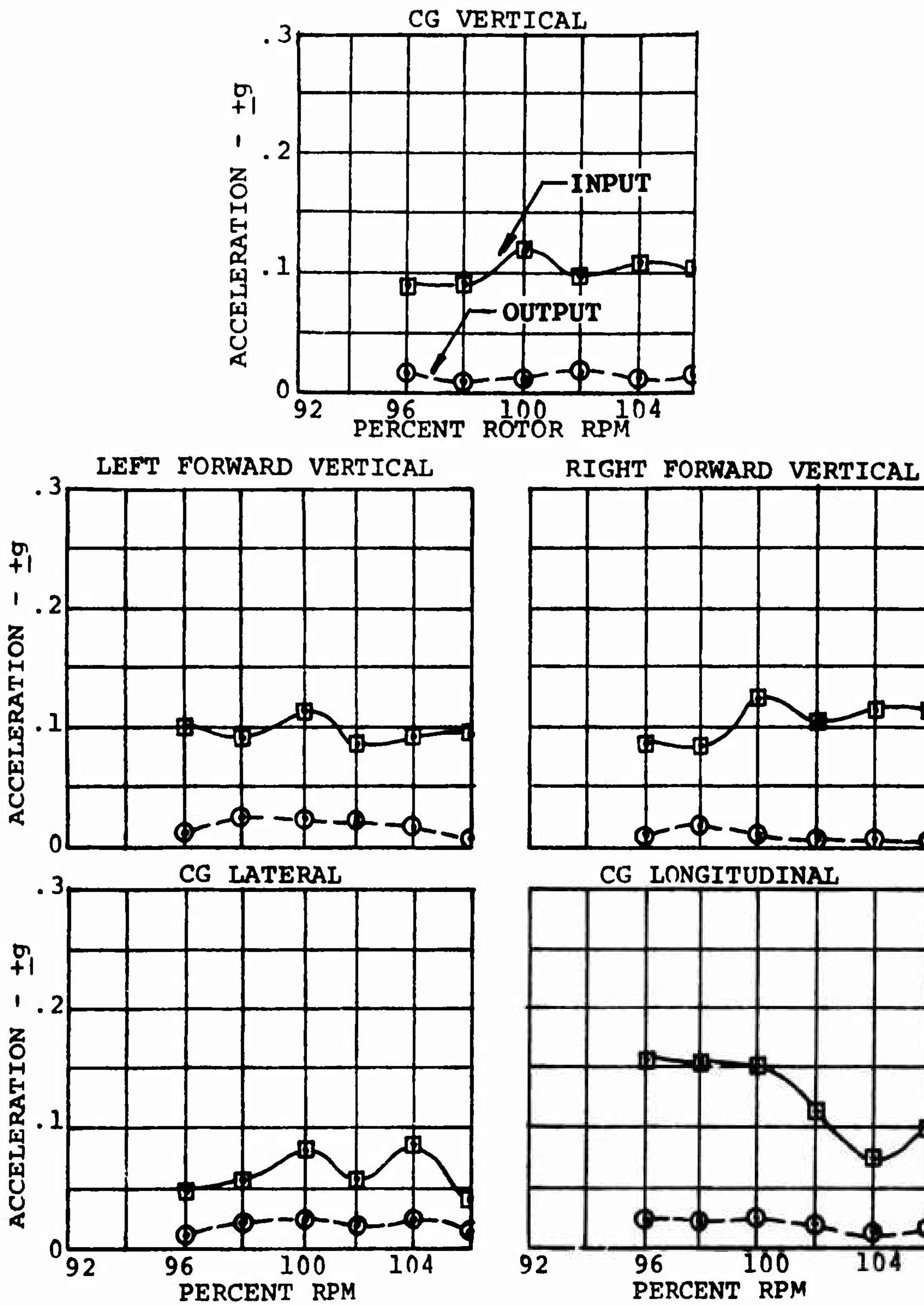


Figure 36. 120-Knot Four-Per-Rev Results of the 200-Pound With a Three-Inch Offset CG Platform With Laterally Oriented Three-Dimensional DAVI's.

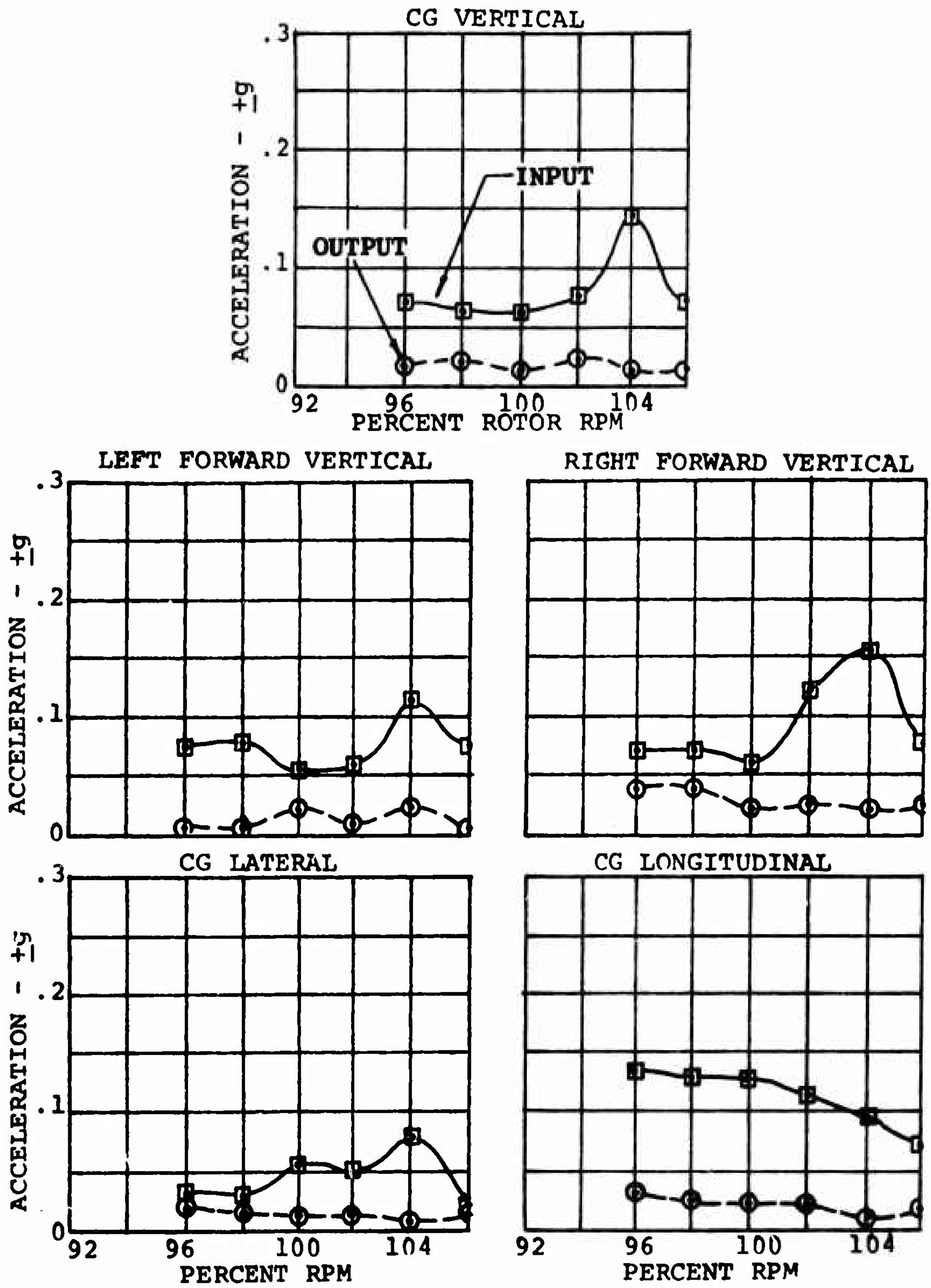


Figure 37. 120-Knot Four-Per-Rev Results of the 200-Pound With a Three-Inch Offset CG Platform With Longitudinally Oriented Three-Dimensional DAVI's.

Figures 27 through 37 show the four-per-rev results obtained. Excellent reduction of vibration level was obtained on all weight configurations of the platform. It is of particular interest that the 50-pound platform had a static deflection of only .031 inch, which for a conventional system would be essentially in resonance at the four-per-rev frequency of the UH-2 helicopter. Flight testing of the 50-pound conventionally isolated platform, reported later in this report, showed this to be true.

It is also seen that orientation of the three-dimensional DAVI's did not affect the results obtained. The platform with the unidirectional inertia bars of the three-dimensional DAVI oriented laterally had lower vibration levels than when oriented longitudinally. There are two major reasons for this discrepancy. Although the three-dimensional DAVI is designed to have the isolated pivots on the elastic axis of the springs, there is non-symmetry in the design. As seen in Figure 13, when the unidirectional inertia bar is oriented in the lateral direction, the springs are equally offset a distance (a) from the pivot axes in the longitudinal direction. As seen from Equations (1) and (2), there is a slight discrepancy in antiresonant frequency.

It is also seen in Figure 13 that in the lateral direction, there is no offset between the springs and the isolated pivots, but that the non-isolated pivot is located a distance (r) from the springs and isolated pivot. As seen from Equations (1) and (3), this also causes a slight discrepancy in antiresonant frequency. Thus, orientation of this three-dimensional DAVI can affect the results.

The effect of orientation of the three-dimensional DAVI was especially noticeable in the 50-pound platform results. The reason for this is that although the antiresonant frequency of the three-dimensional DAVI is not affected by weight of the isolated platform, the natural frequencies of the system are. For the 50-pound platform, the natural frequencies are much closer to the antiresonant frequencies than for the higher weight platforms. This condition does lead to higher vibration when there is a discrepancy in the antiresonant frequencies.

Also higher vibration levels were obtained on the 50-pound platform than on the heavier platforms. This is due to the damping in the system from the friction in the rod-end type bearings. However, excellent isolation was obtained at all platform weights.

COMPARISON OF THEORY AND TEST

Figures 38 through 45 show both the flight test and theoretical results. These results are reported in the form of transmissibilities in which the output accelerations on the platform were divided by the input accelerations to the platform. Figures 38 through 41 show the flight test results for both the lateral and longitudinal orientation of the DAVI. Figures 42 through 45 show the theoretical results. Theoretical results were calculated using a twelve-degree-of-freedom rigid body analysis which is reported in Reference 3.

Correlation of the theoretical results with the flight test results is only fair. One reason for discrepancies is that the analysis is based upon the assumption of point attachment between bodies, and orientation of the DAVI unidirectional inertia bar in the longitudinal or lateral directions is not considered. Therefore, any difference in antiresonant frequency due to orientation of the DAVI cannot be evaluated.

Another reason for discrepancies is that hub forces and moments are used as excitation functions in the theoretical program. Since this is a rigid body program, effective hub forces and moments are used to only reasonably reproduce the inputs to the isolated program. Precise definition of the hub forces and moments that would reproduce the excitation vibration levels and phases obtained in the flight tests was not possible. Constant forces and moments were not used versus rpm and therefore, the theory does not show an antiresonance even though the three-dimensional DAVI system is tuned to 18.5 cps. Because of these assumptions in the theoretical program, precise correlation cannot be obtained. However, the theory is perfectly adequate in designing an isolated program.

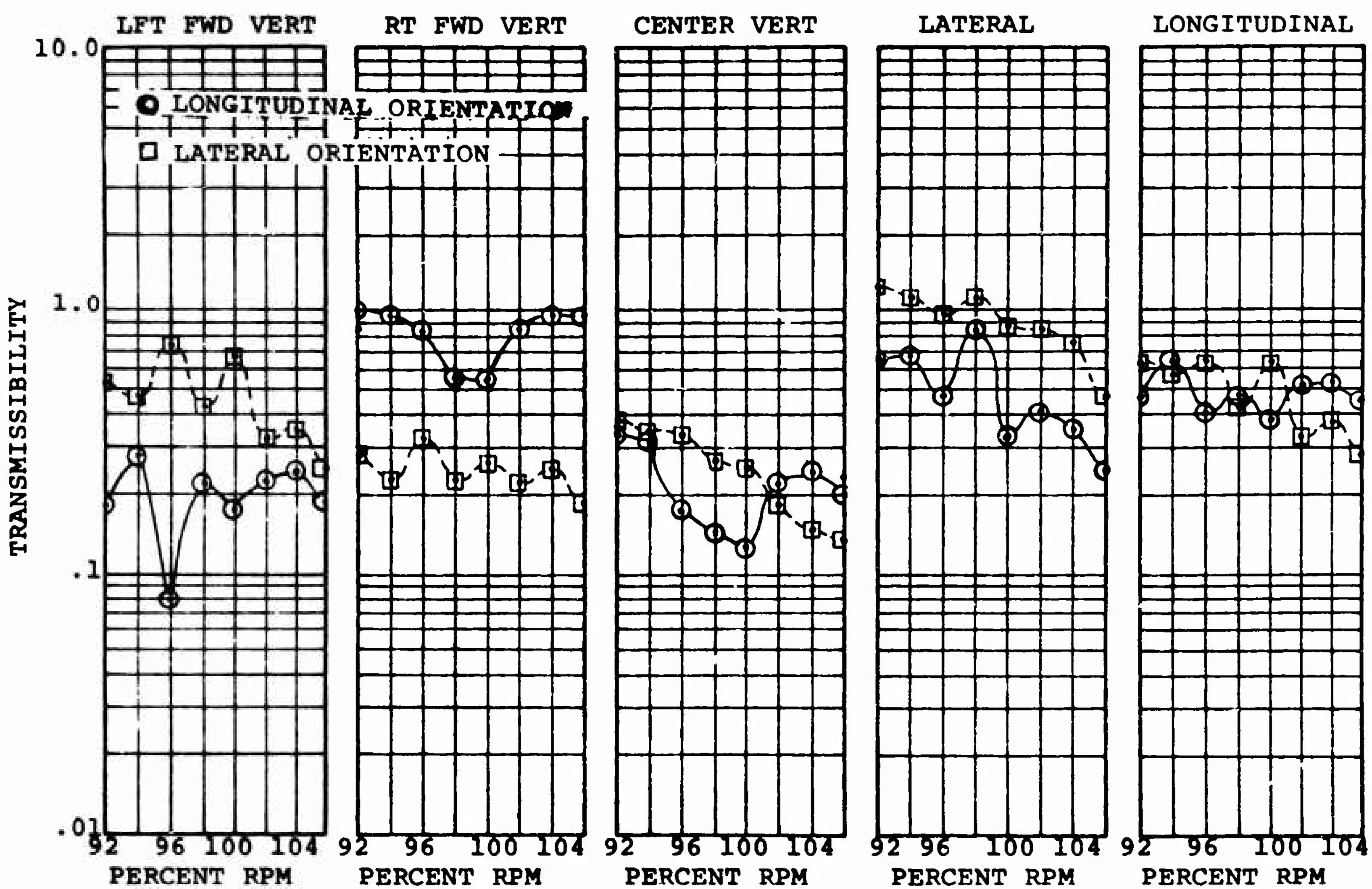


Figure 38. Flight Test Transmissibility Results of the 50-Pound Three-Dimensional DAVI Platform.

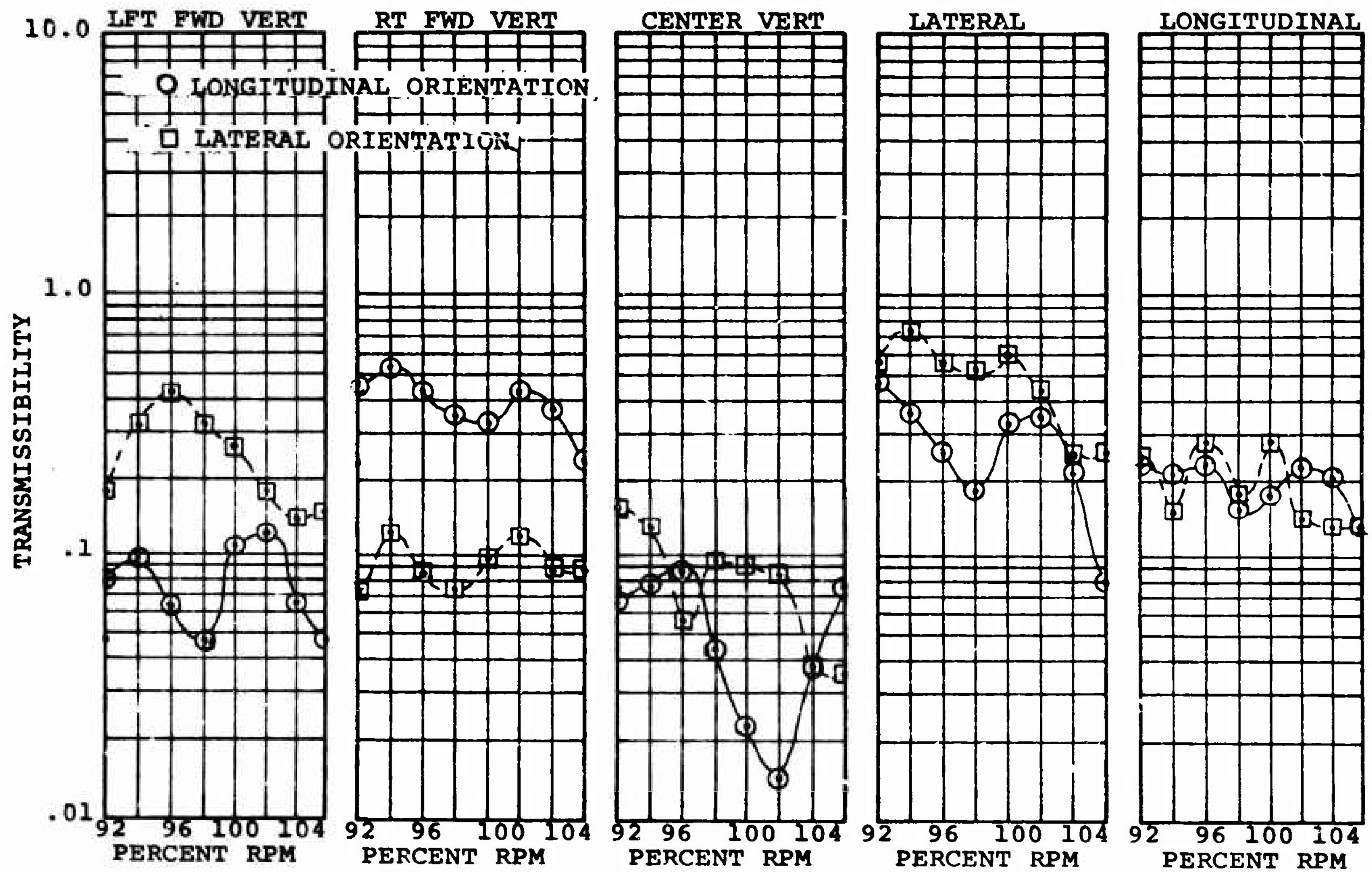


Figure 39. Flight Test Transmissibility Results of the 150-Pound Three-Dimensional DAVI Platform.

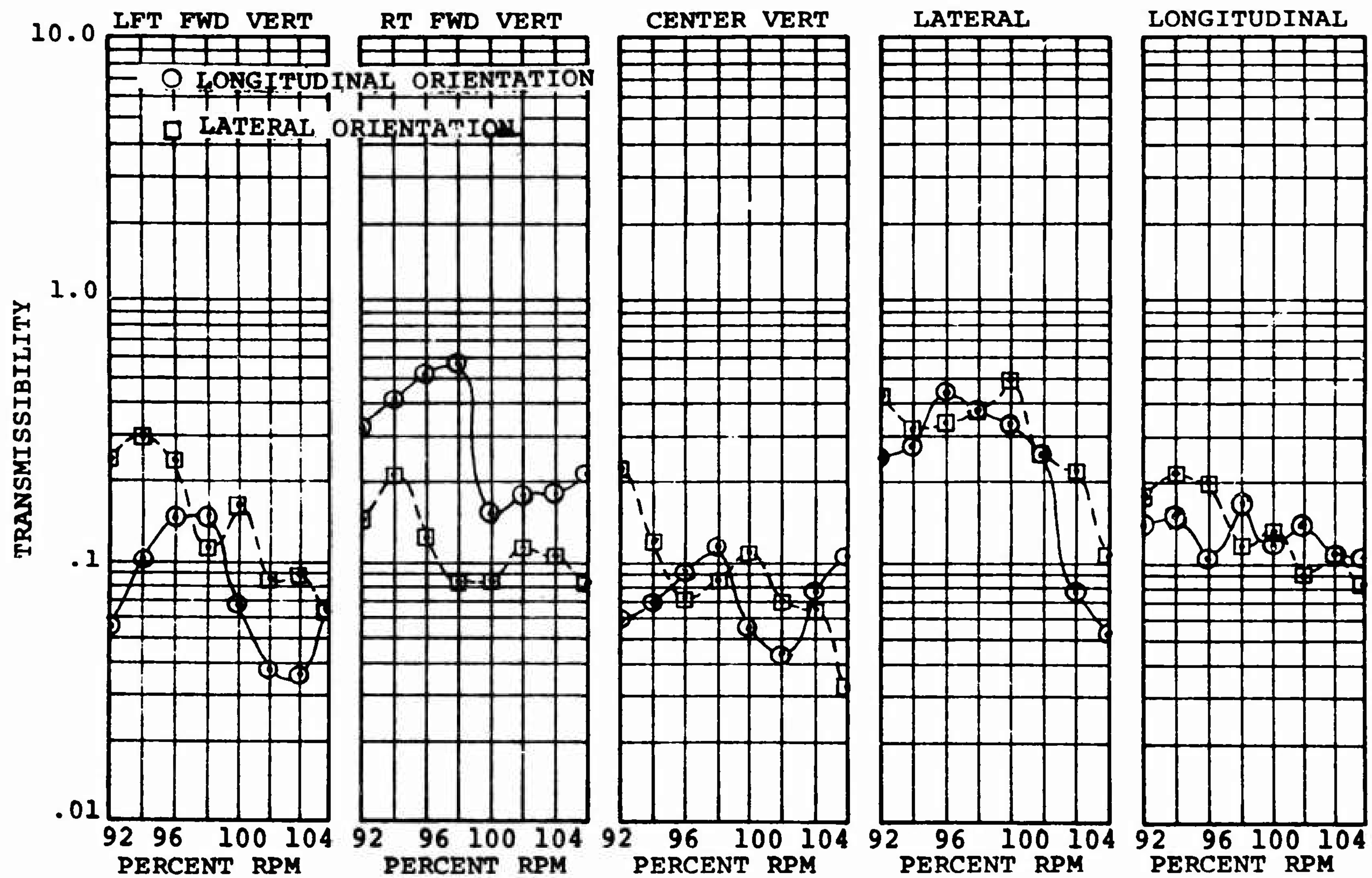


Figure 40. Flight Test Transmissibility Results of the 200-Pound Three-Dimensional DAVI Platform.

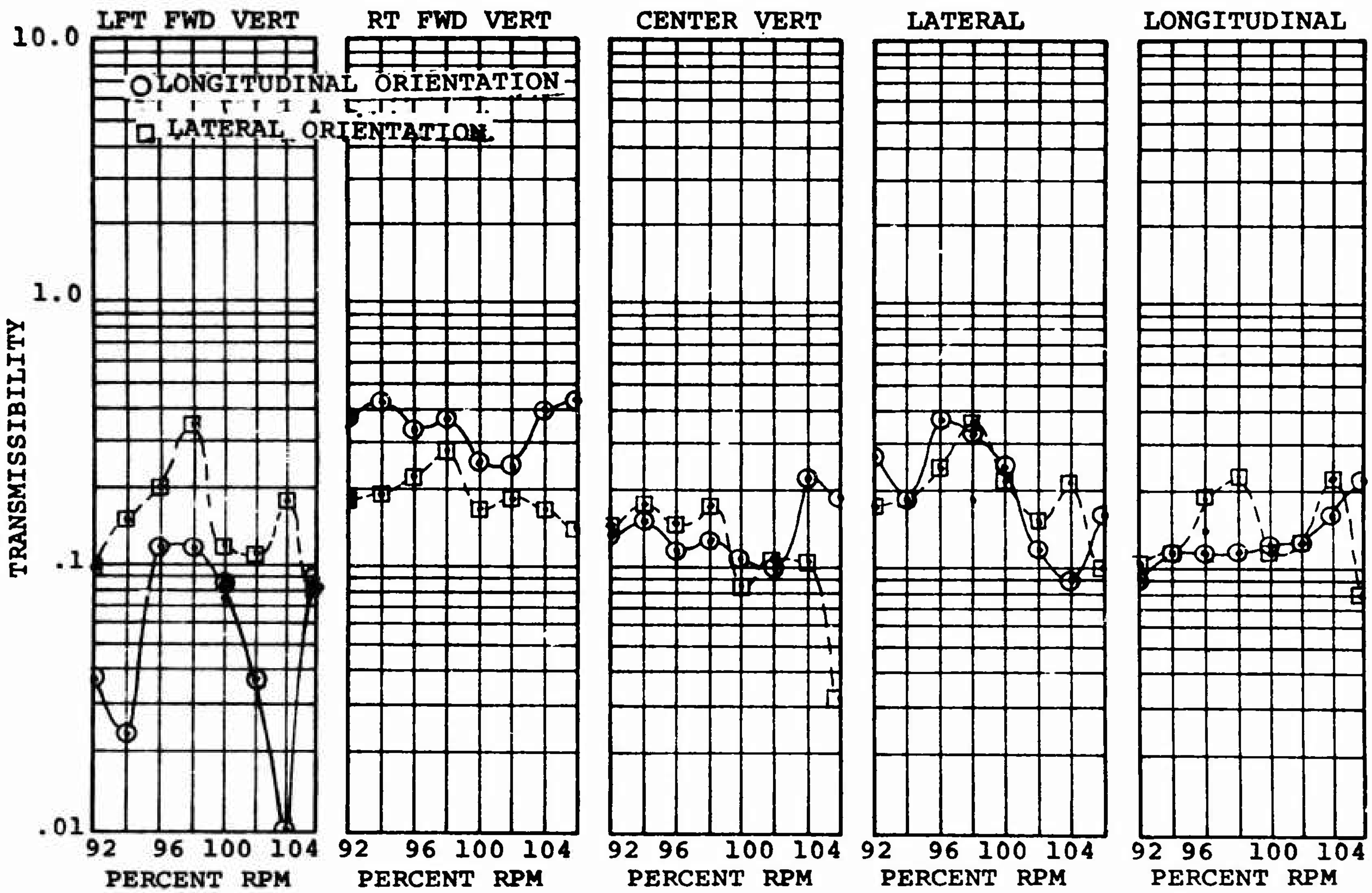


Figure 41. Flight Test Transmissibility Results of the 200-Pound With Offset CG Three-Dimensional DAVI Platform.

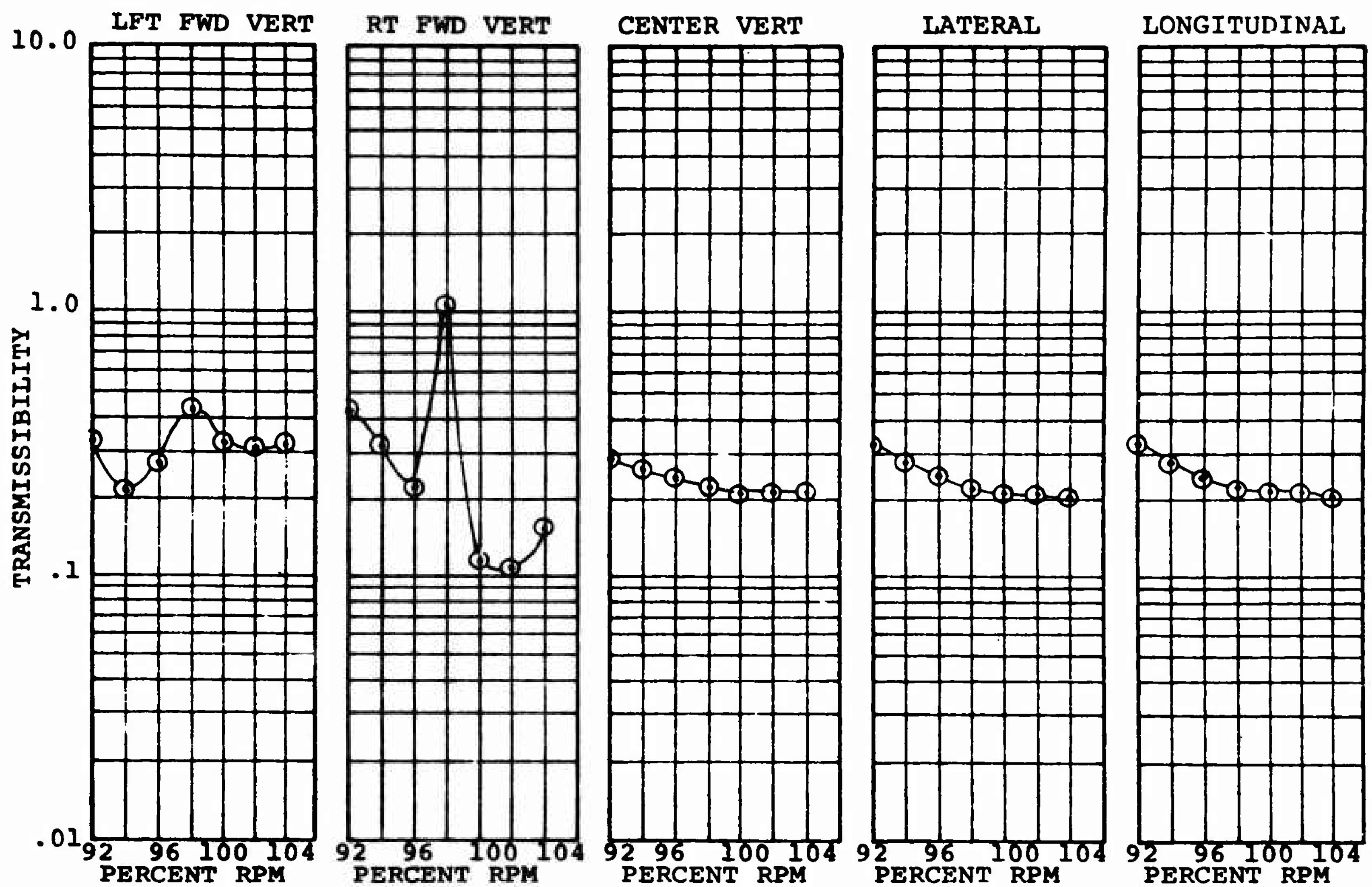


Figure 42. Theoretical Transmissibility Results of the 50-Pound Three-Dimensional DAVI Platform.

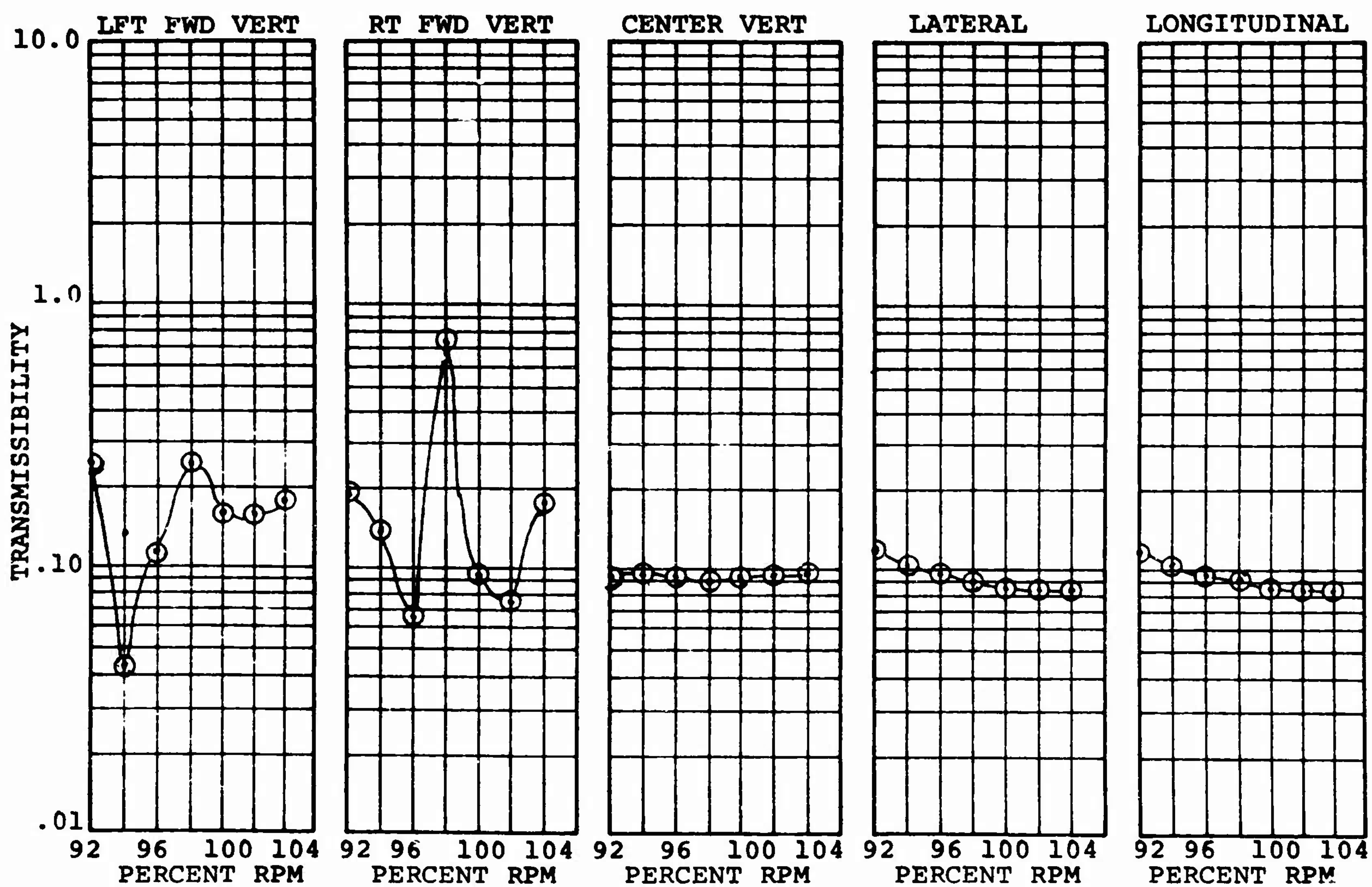


Figure 43. Theoretical Transmissibility Results of the 150-Pound Three-Dimensional DAVI Platform.

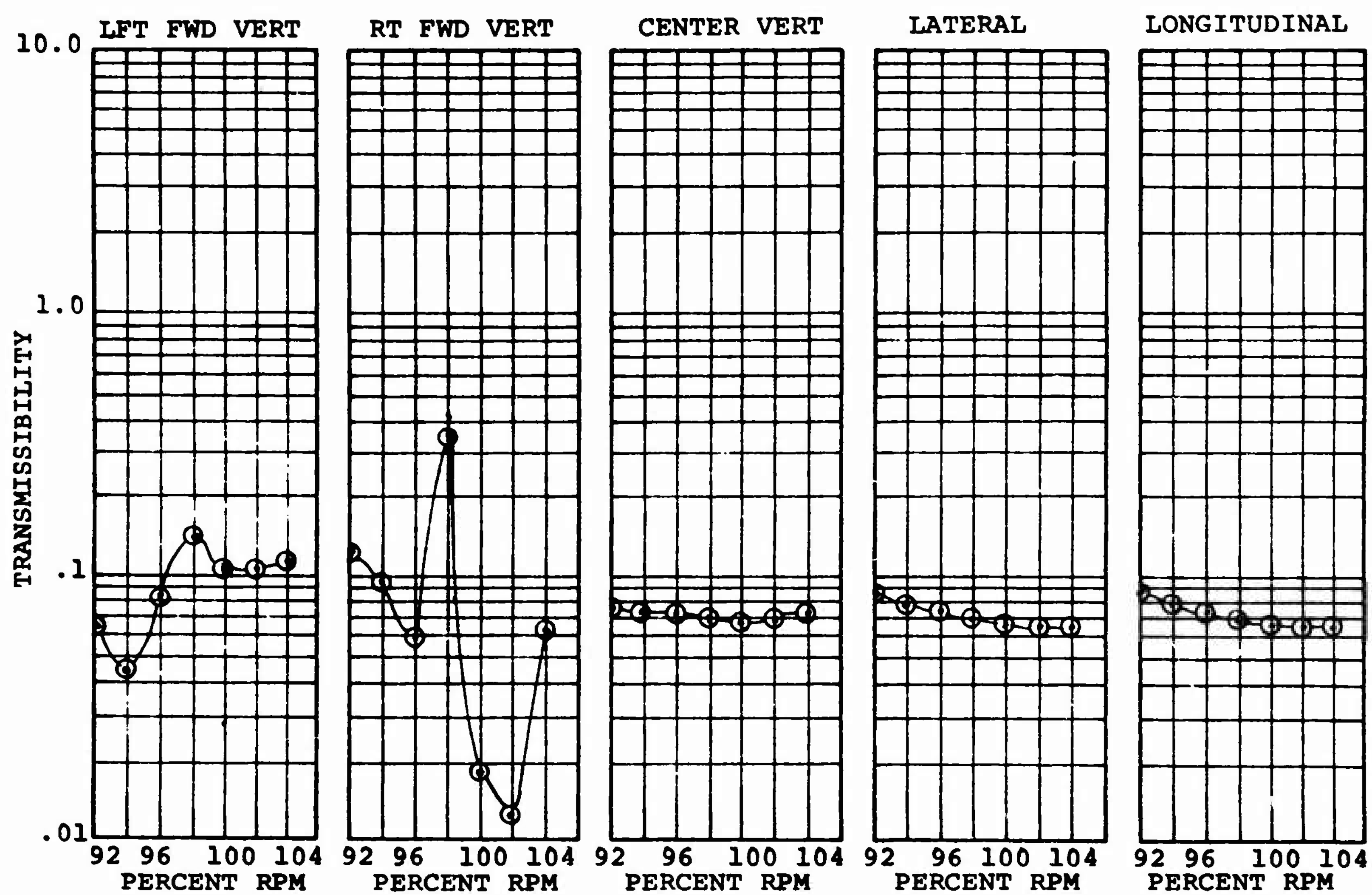


Figure 44. Theoretical Transmissibility Results of the 200-Pound Three-Dimensional DAVI Platform.

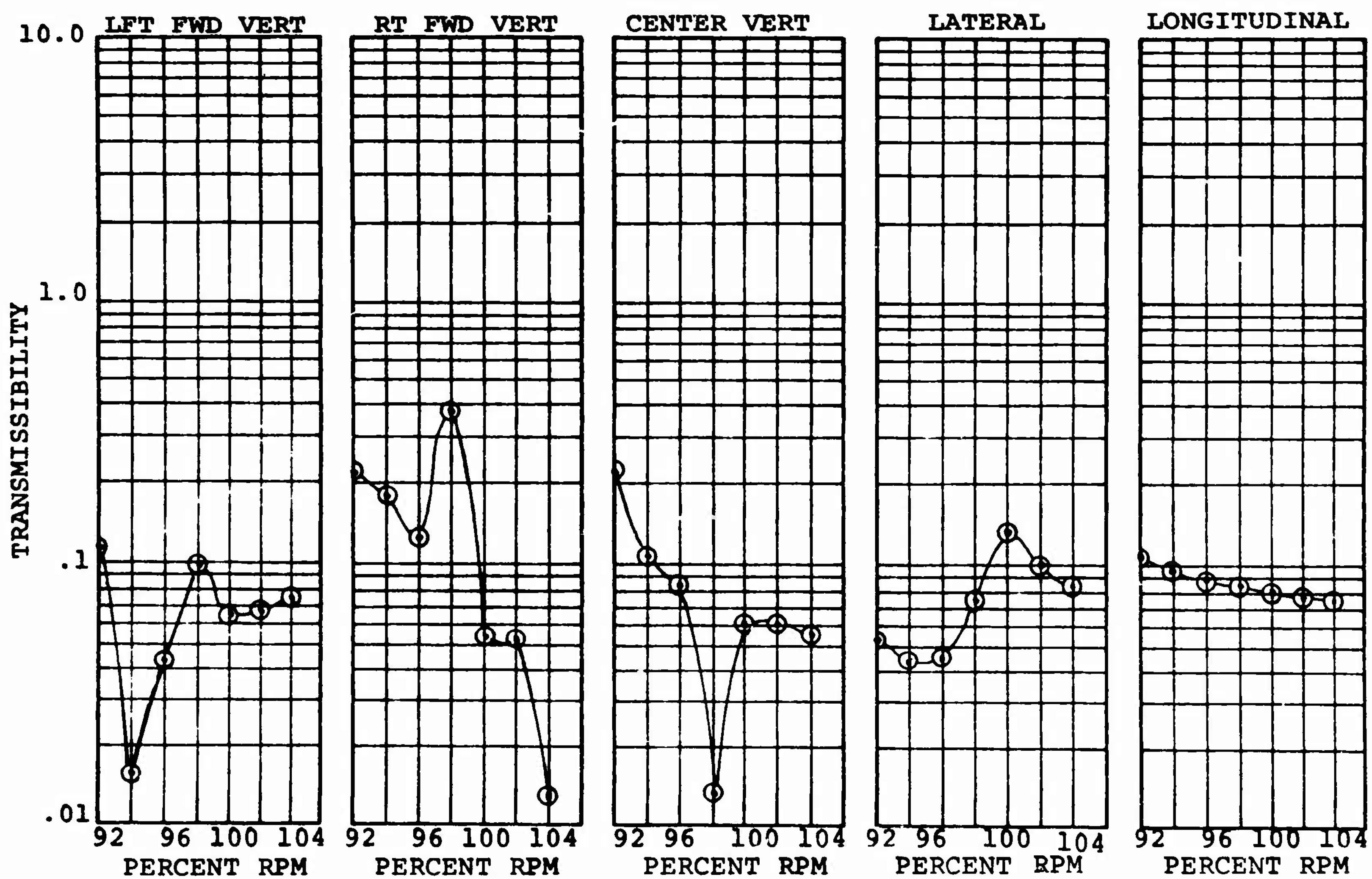


Figure 45. Theoretical Transmissibility Results of the 200-Pound With Offset CG Three-Dimensional DAVI Platform.

CONVENTIONAL SYSTEM

CONVENTIONAL PLATFORM

Four weight configurations of the conventional platform were flight tested: a 50-pound platform, a 150-pound platform, a 200-pound platform, and a 200-pound platform with a three-inch center of gravity offset. The platform was essentially the same as the three-dimensional DAVI platform, and the conventional system was obtained by removing the inertia bar of the two-dimensional DAVI. The two-dimensional DAVI platform results are reported later in this report. The instrumentation and location used in this phase are identical to those in the three-dimensional DAVI flight test phase.

FLIGHT TEST CONDITIONS

The conventional platform was tested under steady-state or level flight conditions and transient conditions. The flight testing was conducted on Kaman UH-2B helicopter BuNo 147204. Table V gives the conditions tested. These were all tested for a helicopter gross weight of 8500 pounds.

FLIGHT TEST RESULTS

Figures 46 through 49 and Figures 50 through 53 show typical oscillograph traces obtained in the level flight and transient conditions, respectively. These figures of the steady-state conditions show the results obtained on the conventional platform at 30 knots and 100 percent rotor rpm. It is seen that the 50-pound platform was essentially in resonance and a large increase in vibration occurred. Isolation was obtained on the 150-pound and 200-pound platforms.

Figures 50 through 53 show the transient condition of landing, since this is more critical than rotor engagement. These traces show that no abnormal g level was obtained.

TABLE V. CONVENTIONAL ISOLATED PLATFORM FLIGHT TEST CONDITIONS

Platform Weight (lb)	Platform Center of Gravity Offset (in.)	Main Rotor Speed (% rpm)	Airspeed (kn)
50	0	92 to 102	30
50	0	92 to 102	120
50	0	100	Landing
50	0	0 to 100	Ground Rev-Up
150	0	92 to 102	30
150	0	92 to 102	120
150	0	100	Landing
150	0	0 to 100	Ground Rev-Up
200	0	92 to 102	30
200	0	92 to 102	120
200	0	100	Landing
200	0	0 to 100	Ground Rev-Up
200	3	92 to 102	30
200	3	92 to 102	120
200	3	100	Landing
200	3	0 to 100	Ground Rev-Up

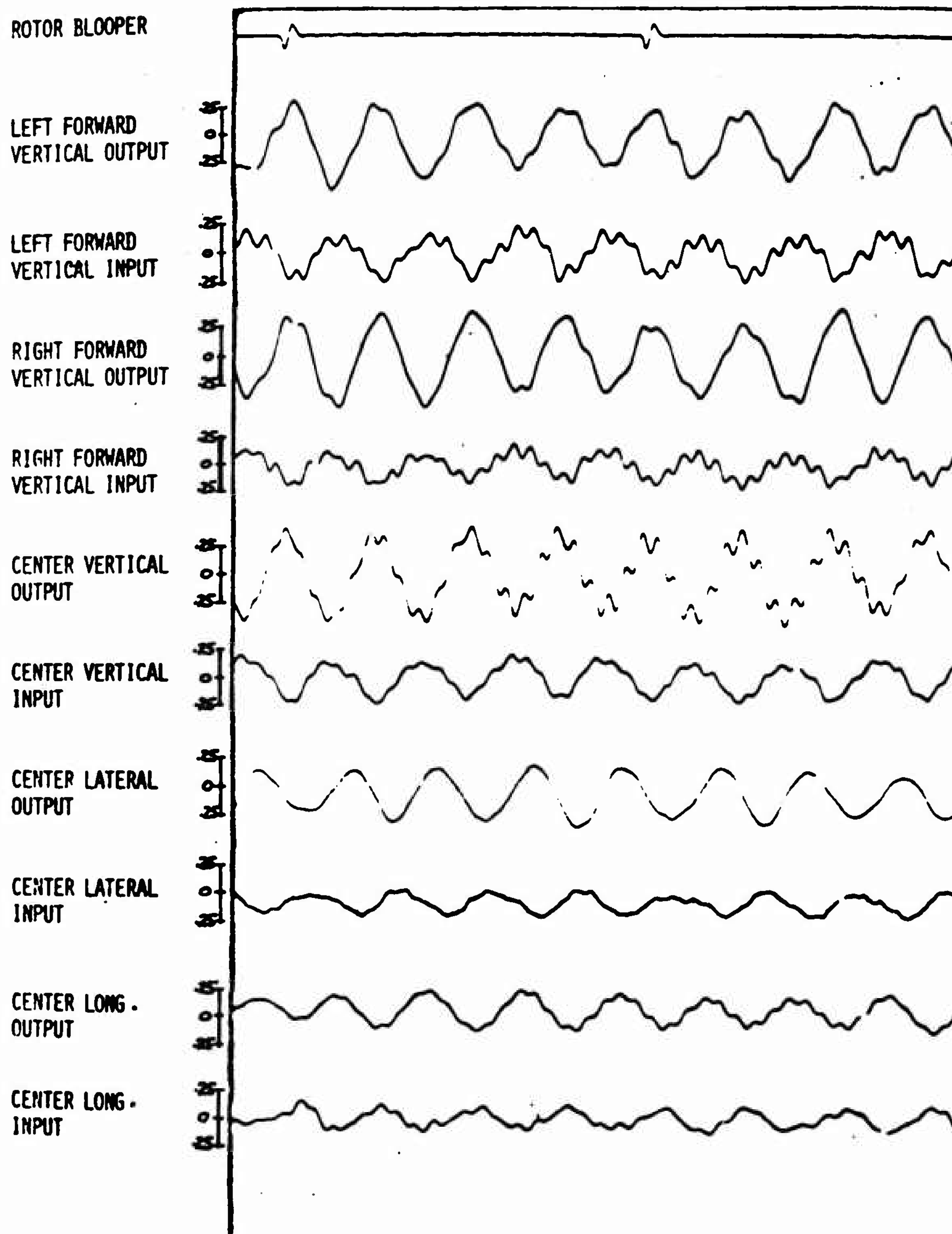


Figure 46. 50-Pound Conventional Platform Level Flight Oscillograph Traces.

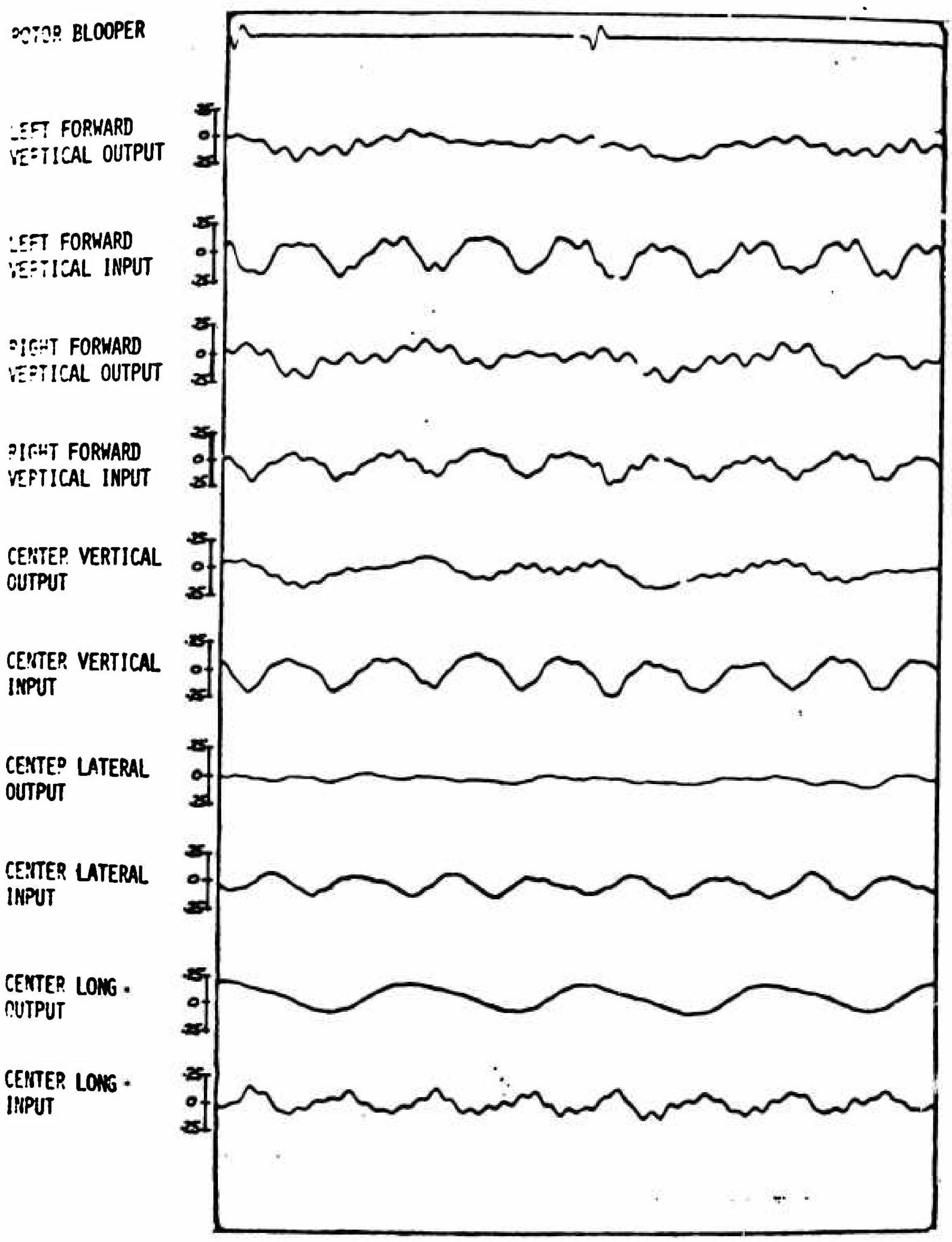


Figure 47. 150-Pound Conventional Platform Level Flight Oscillograph Traces.

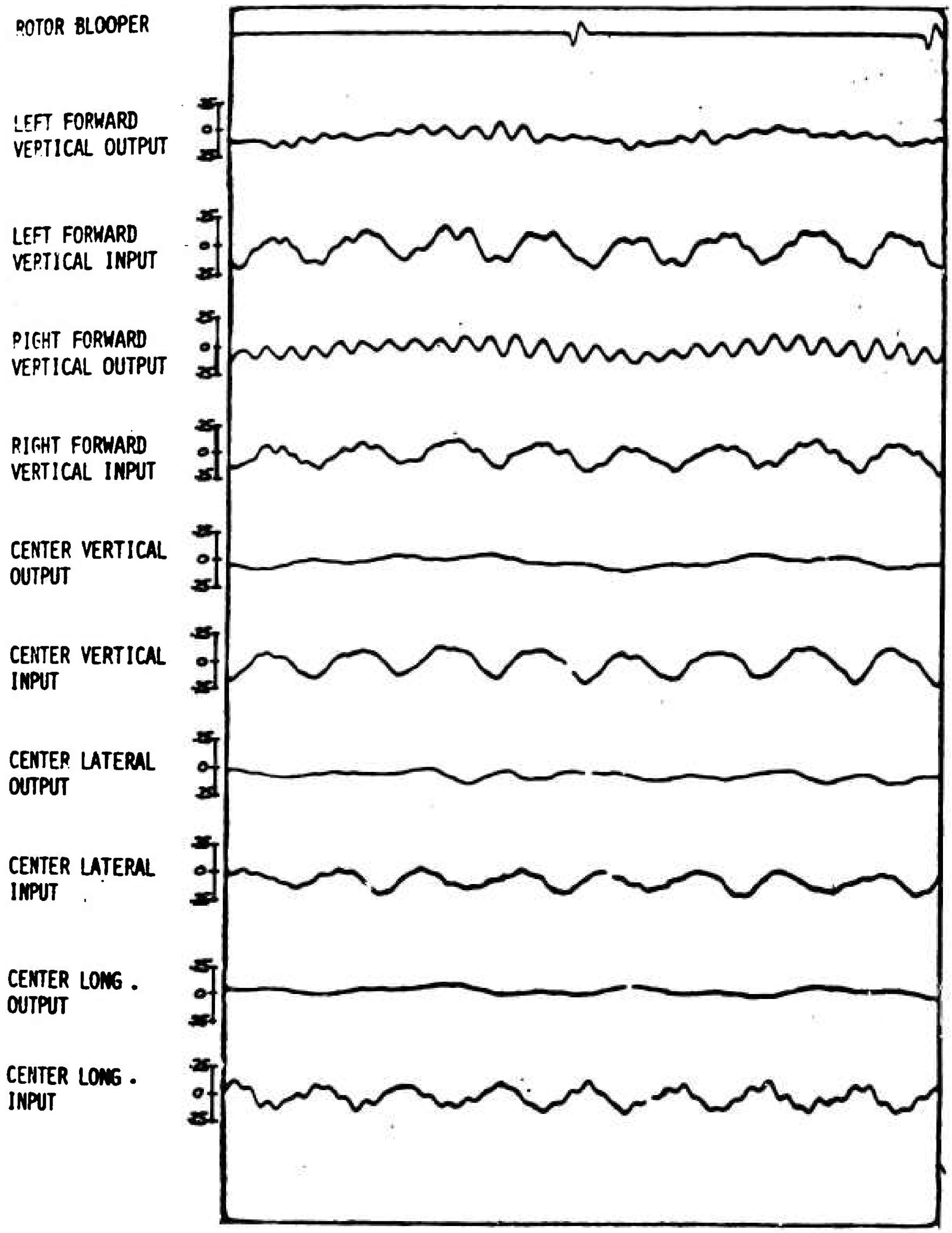


Figure 48. 200-Pound Conventional Platform Level Flight Oscillograph Traces.

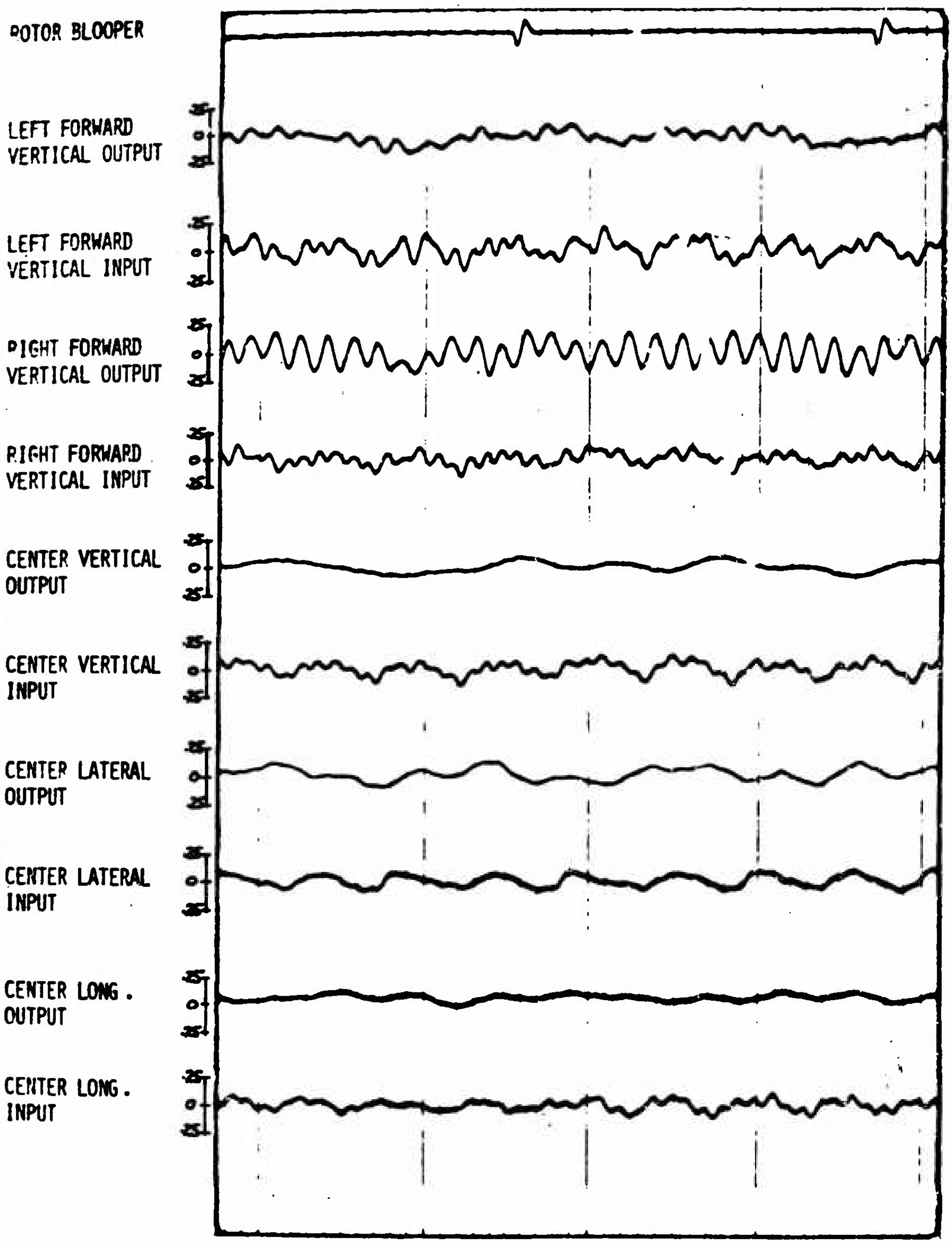


Figure 49. 200-Pound With Three-Inch CG Offset Conventional Platform Level Flight Oscillograph Traces.

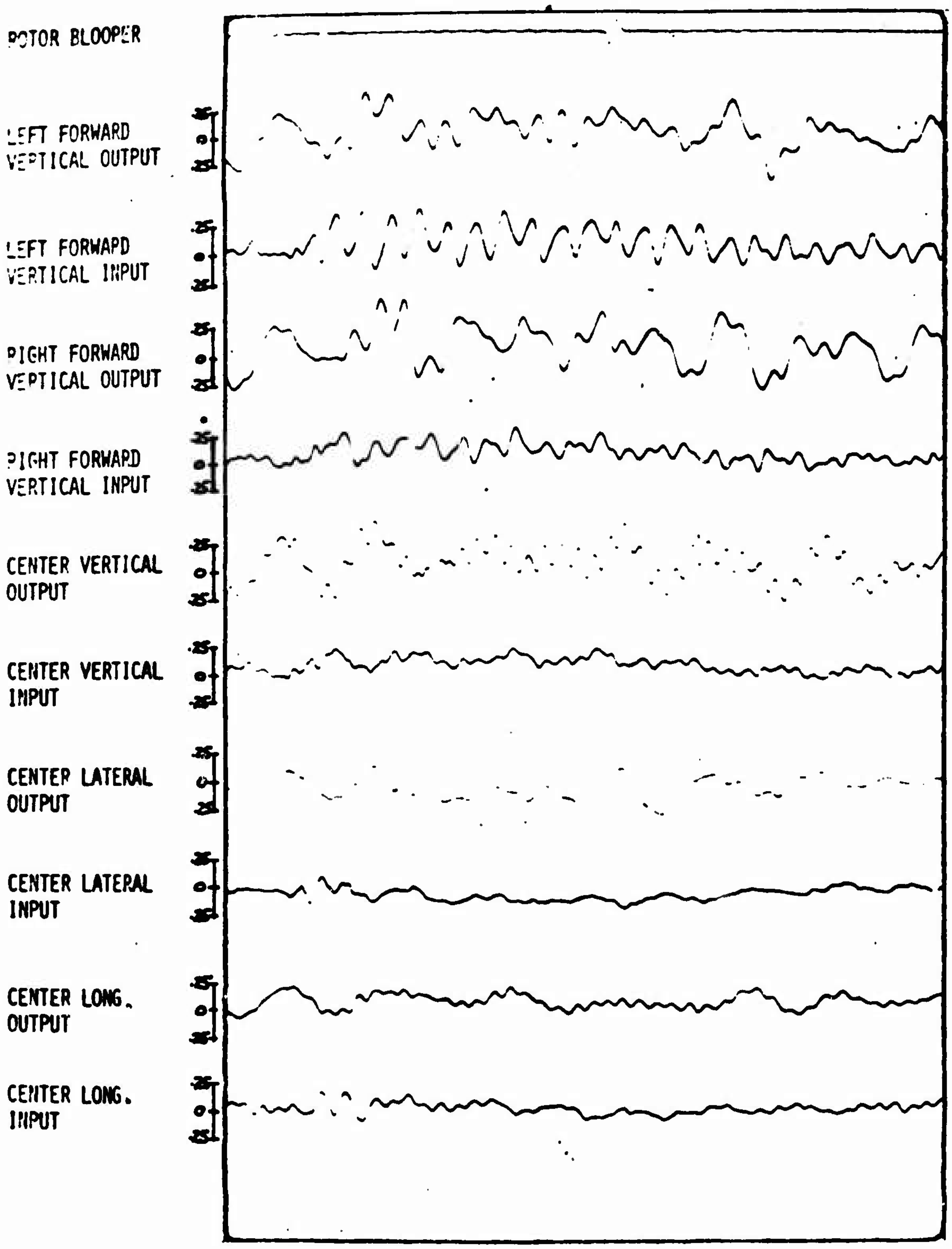


Figure 50. 50-Pound Conventional Platform Oscillograph Traces of the Landing Condition.

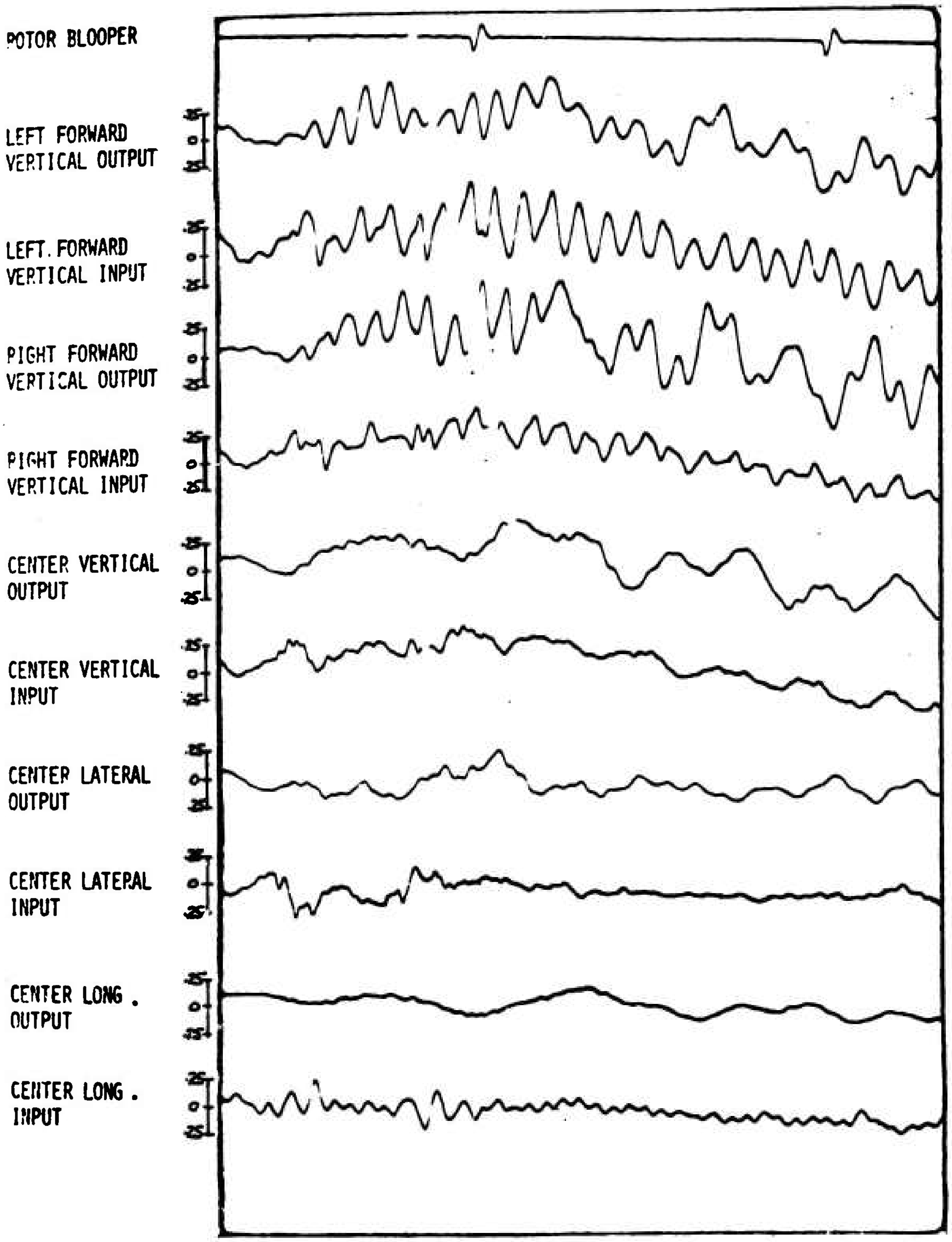


Figure 51. 150-Pound Conventional Platform Oscillograph Traces of the Landing Condition.

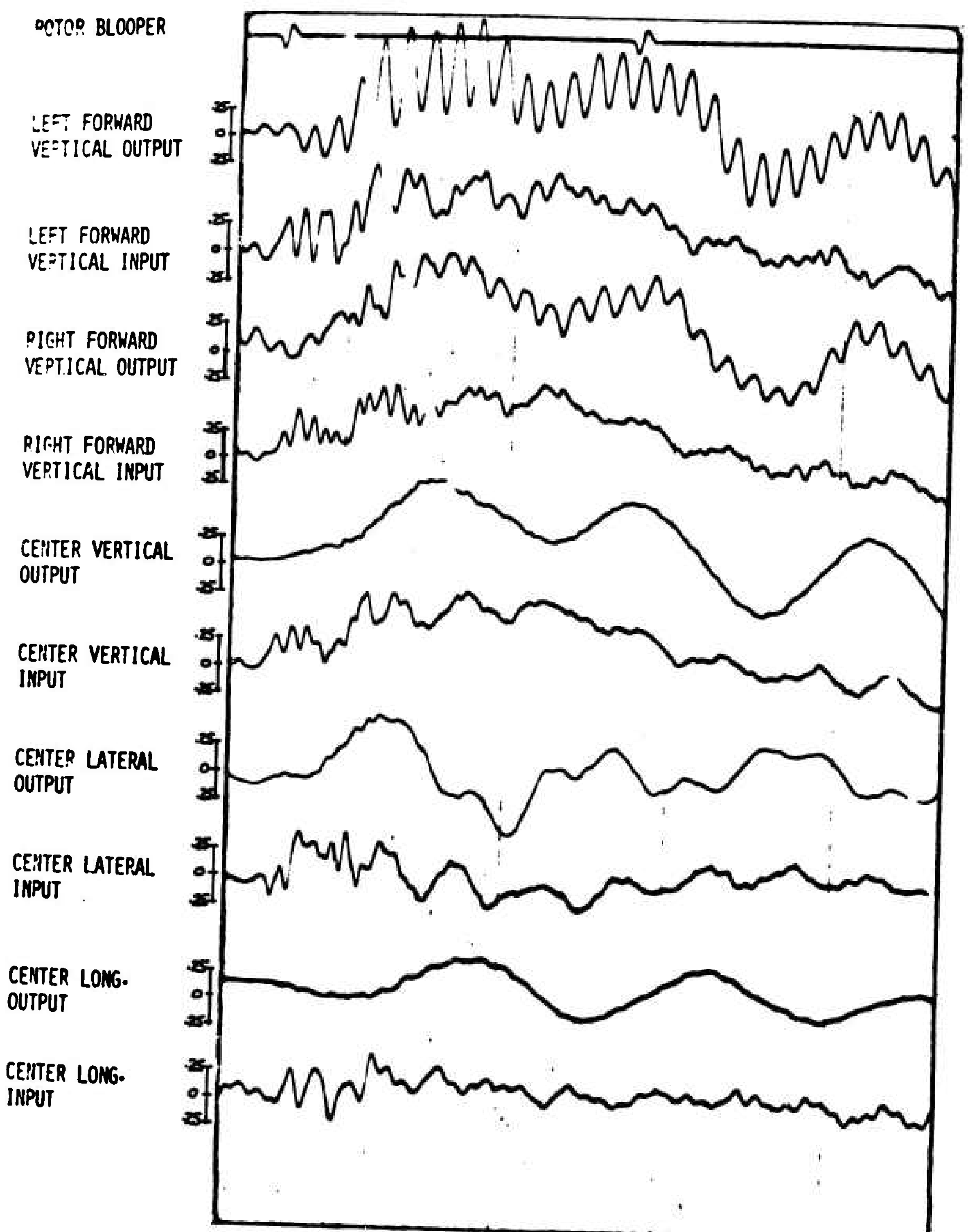


Figure 52. 200-Pound Conventional Platform Oscillograph Traces of the Landing Condition.

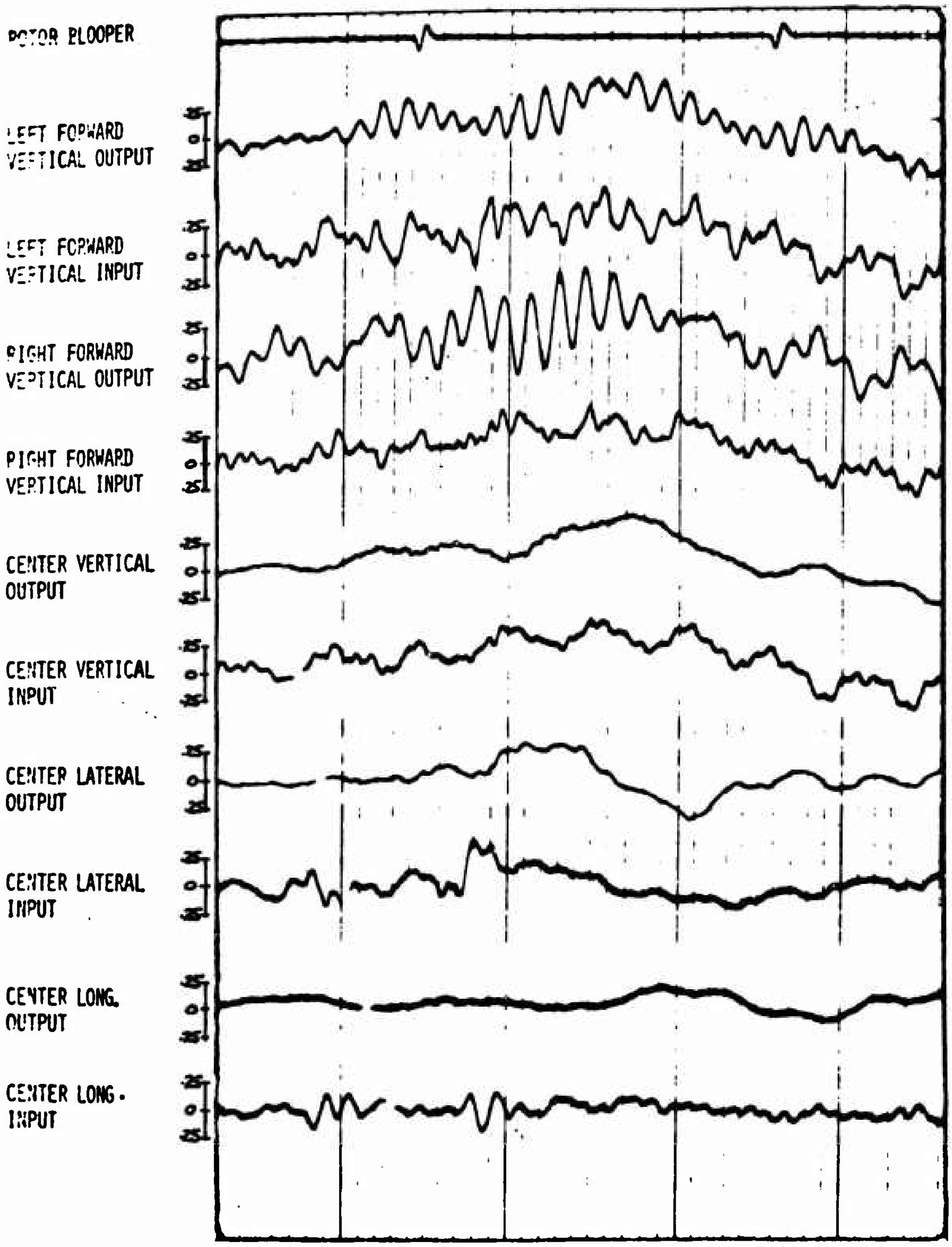


Figure 53. 200-Pound With Three-Inch CG Offset Conventional Platform Oscillograph Traces of the Landing Condition.

A 48-point Fourier analysis was done on the test data to obtain the magnitude of the predominant harmonics. This analysis was done on all of the steady-state test conditions. Table VI gives the frequencies of the predominant harmonics.

TABLE VI. FREQUENCY OF THE PREDOMINANT HARMONICS OF THE UH-2B HELICOPTER

Main Rotor Speed (Percent RPM)	Frequency of Predominant Harmonic (Cycles Per Second)				
	1	4	8	12	16
92	4.24	16.96	33.92	50.88	67.84
94	4.33	17.32	34.64	51.96	69.28
96	4.43	17.72	35.44	53.16	70.88
98	4.52	18.08	36.16	54.24	72.32
100	4.61	18.44	36.88	55.32	73.70
102	4.70	18.80	37.60	56.40	75.20

The Fourier analysis results are given in Table VII for the one-per-rev and eight-per-rev and in Figures 54 through 61 for the four-per-rev.

It is seen from Table VII that the one-per-rev vibration levels in most cases are of very low magnitude. The one-per-rev vibration levels were greater on the platform than the input to the platform. This is to be expected, since the natural frequency of all the weight configurations were above one-per-rev, and amplification should occur. However, none of the one-per-rev vibration levels on the platform were high. In most cases, the eight-per-rev level inputs were low, and for the eight-per-rev, good attenuation was obtained on the platform.

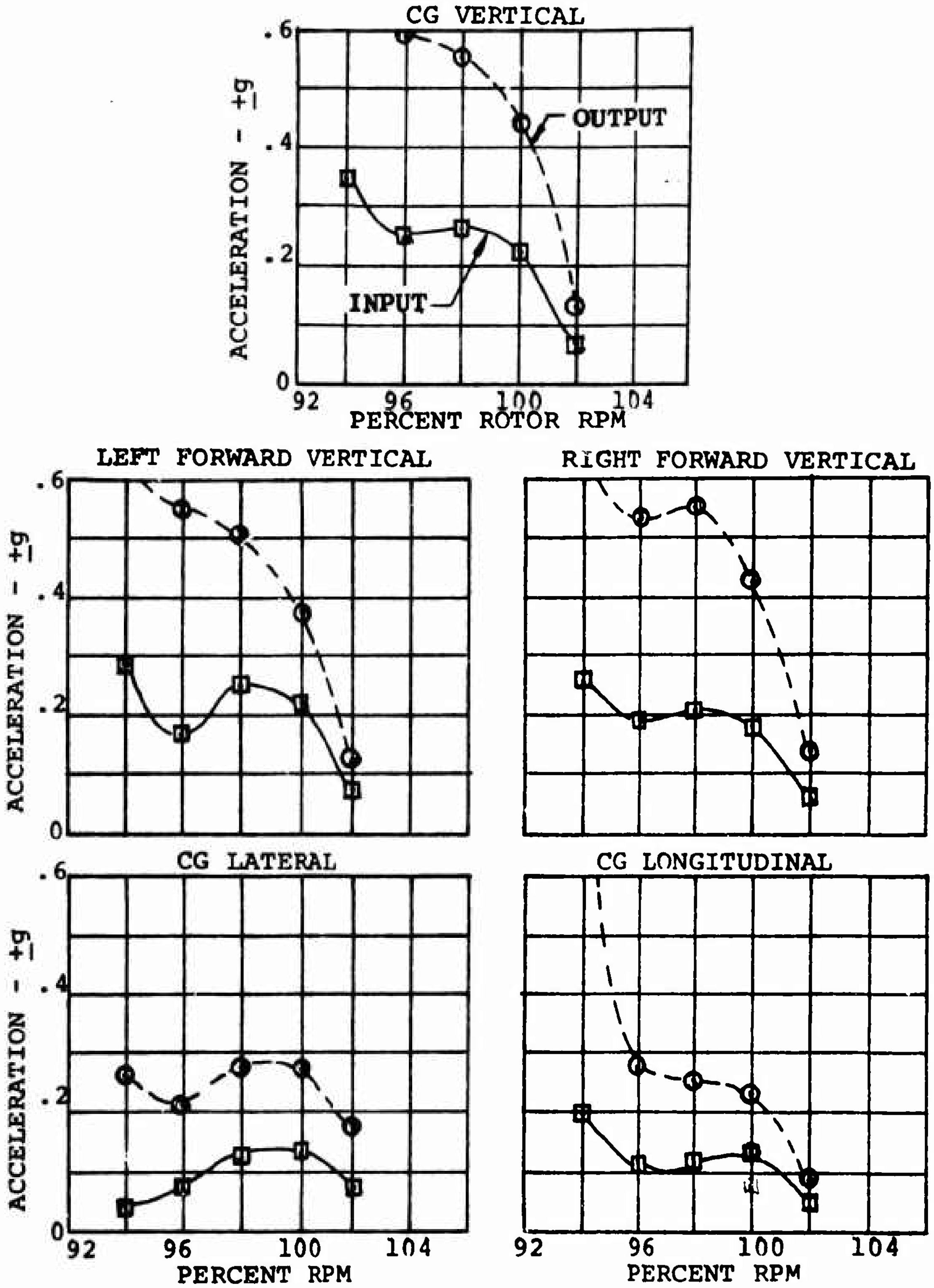


Figure 54. 30-Knot Four-Per-Rev Results of the 50-Pound Conventional Platform.

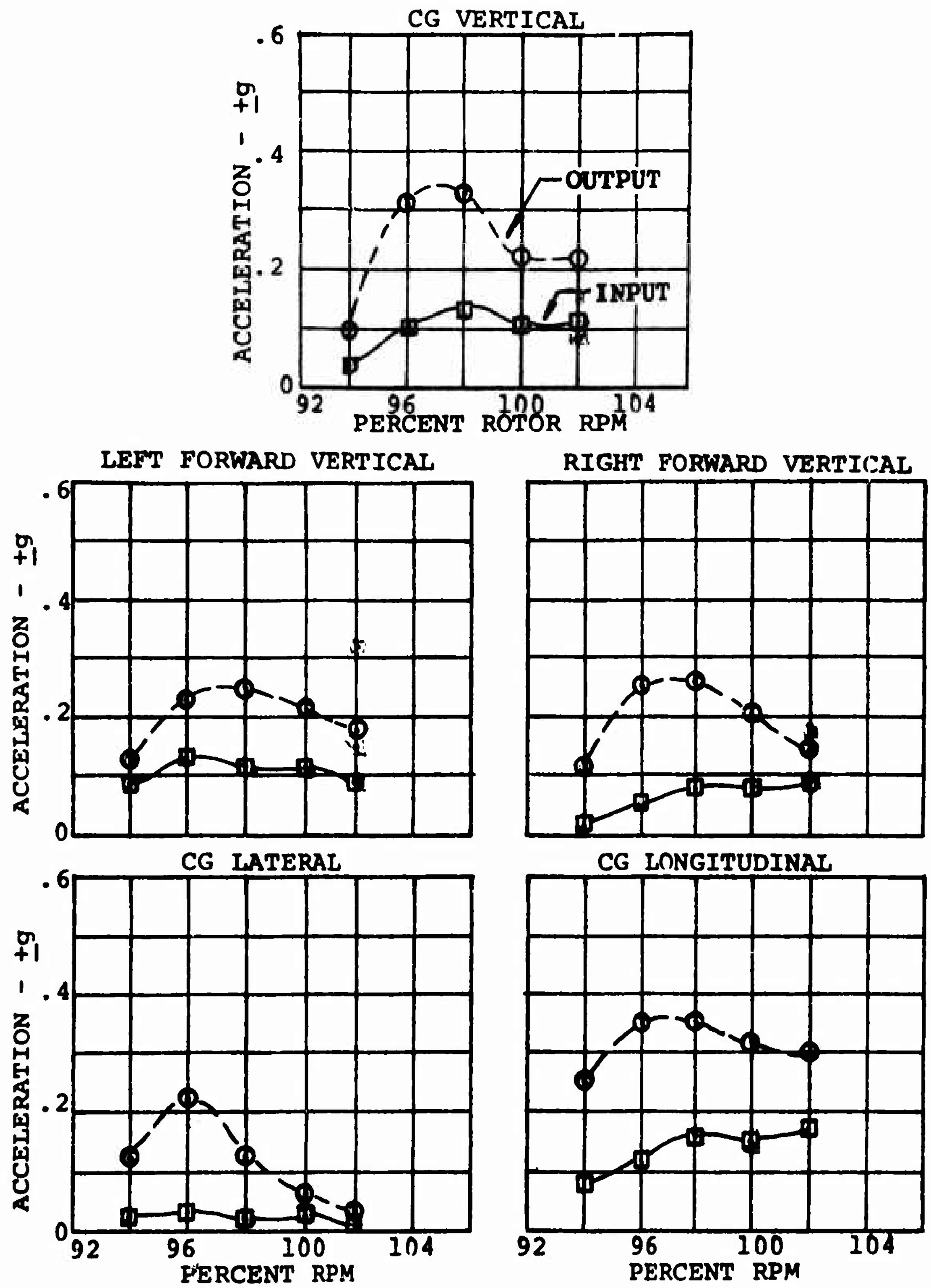


Figure 55. 120-Knot Four-Per-Rev Results of the 50-Pound Conventional Platform.

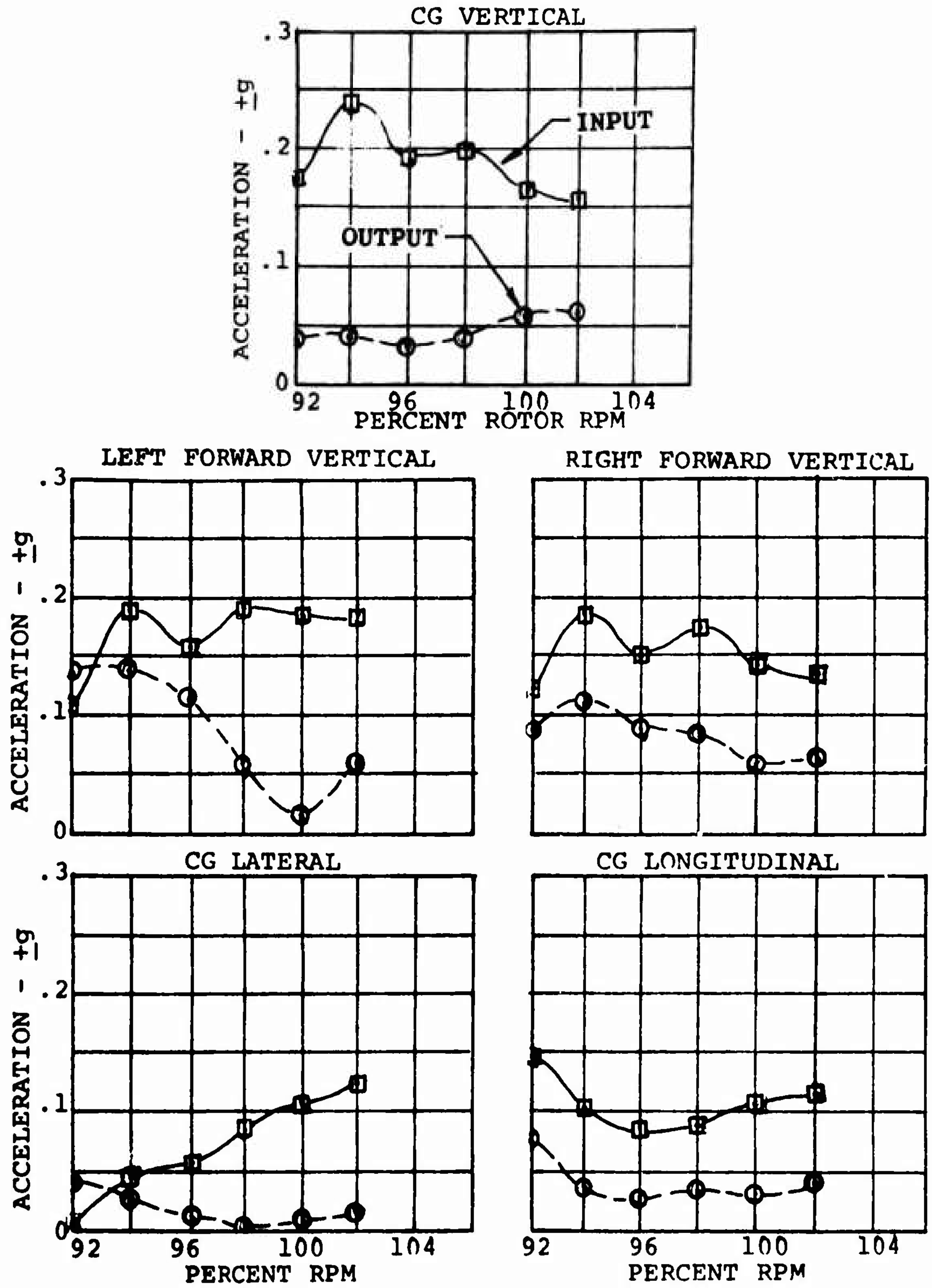


Figure 56. **30-Knot Four-Per-Rev Results of the 150-Pound Conventional Platform.**

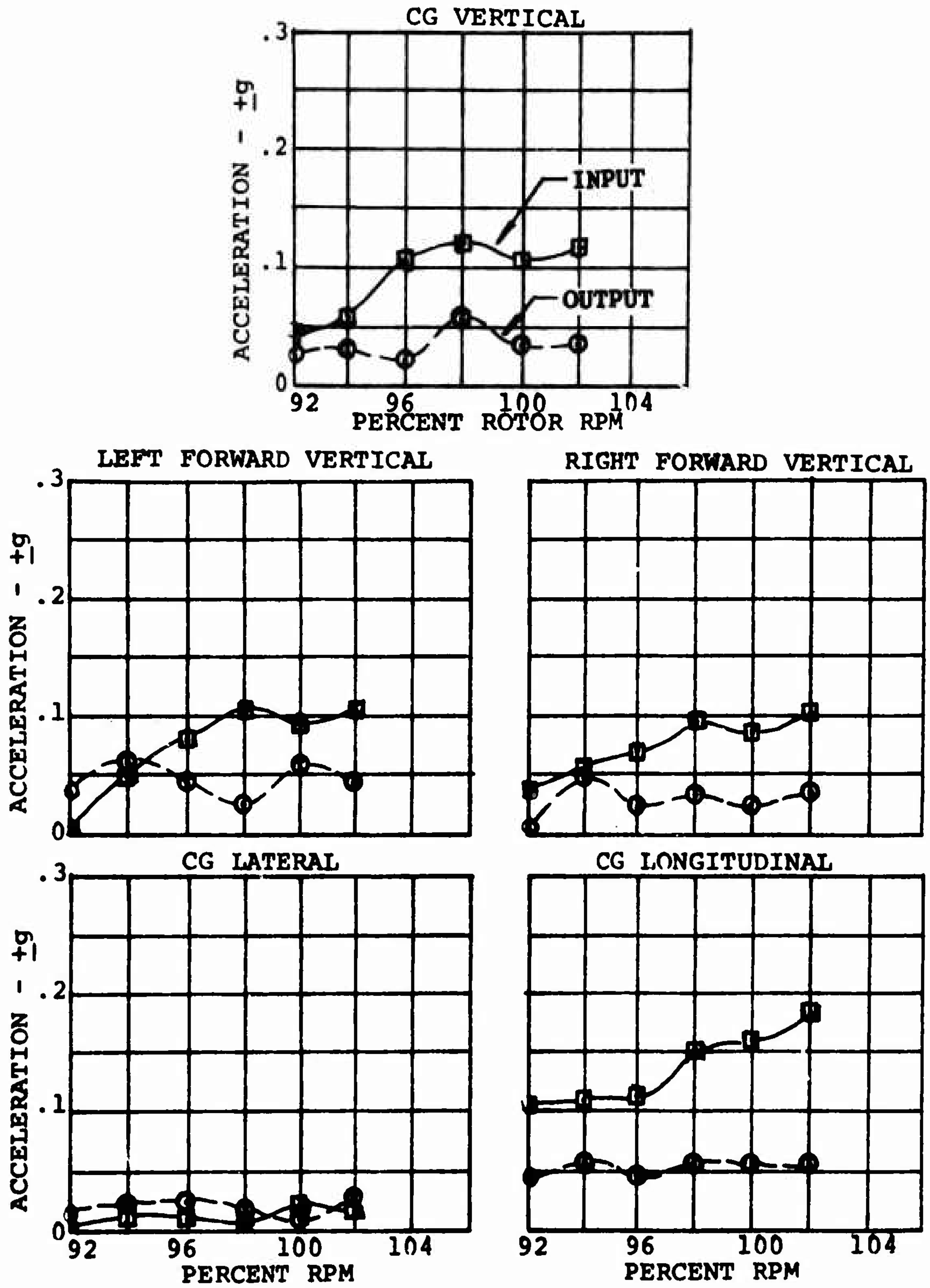


Figure 57. 120-Knot Four-Per-Rev Results of the 150-Pound Conventional Platform.

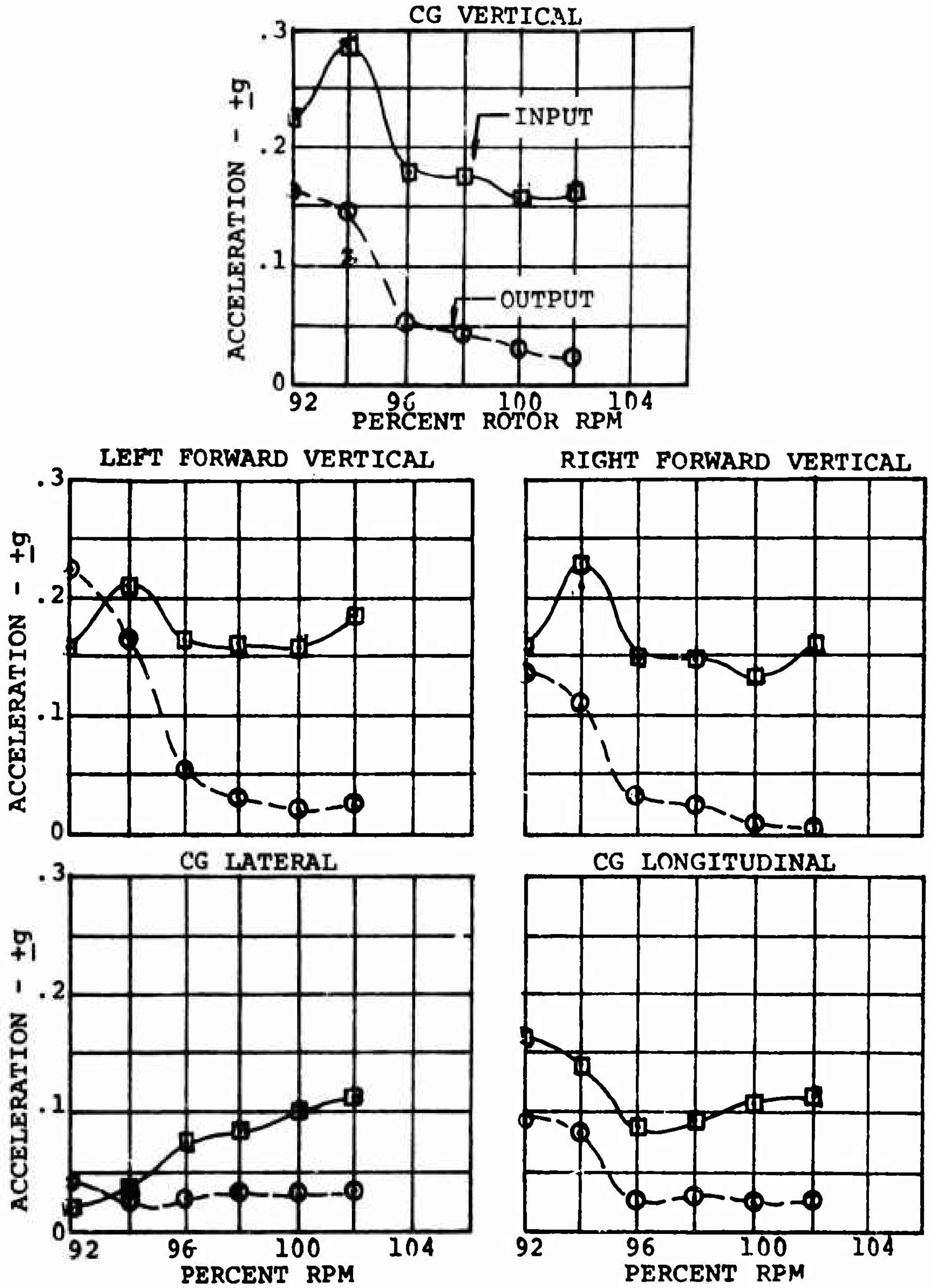


Figure 58. 30-Knot Four-Per-Rev Results of the 200-Pound Conventional Platform.

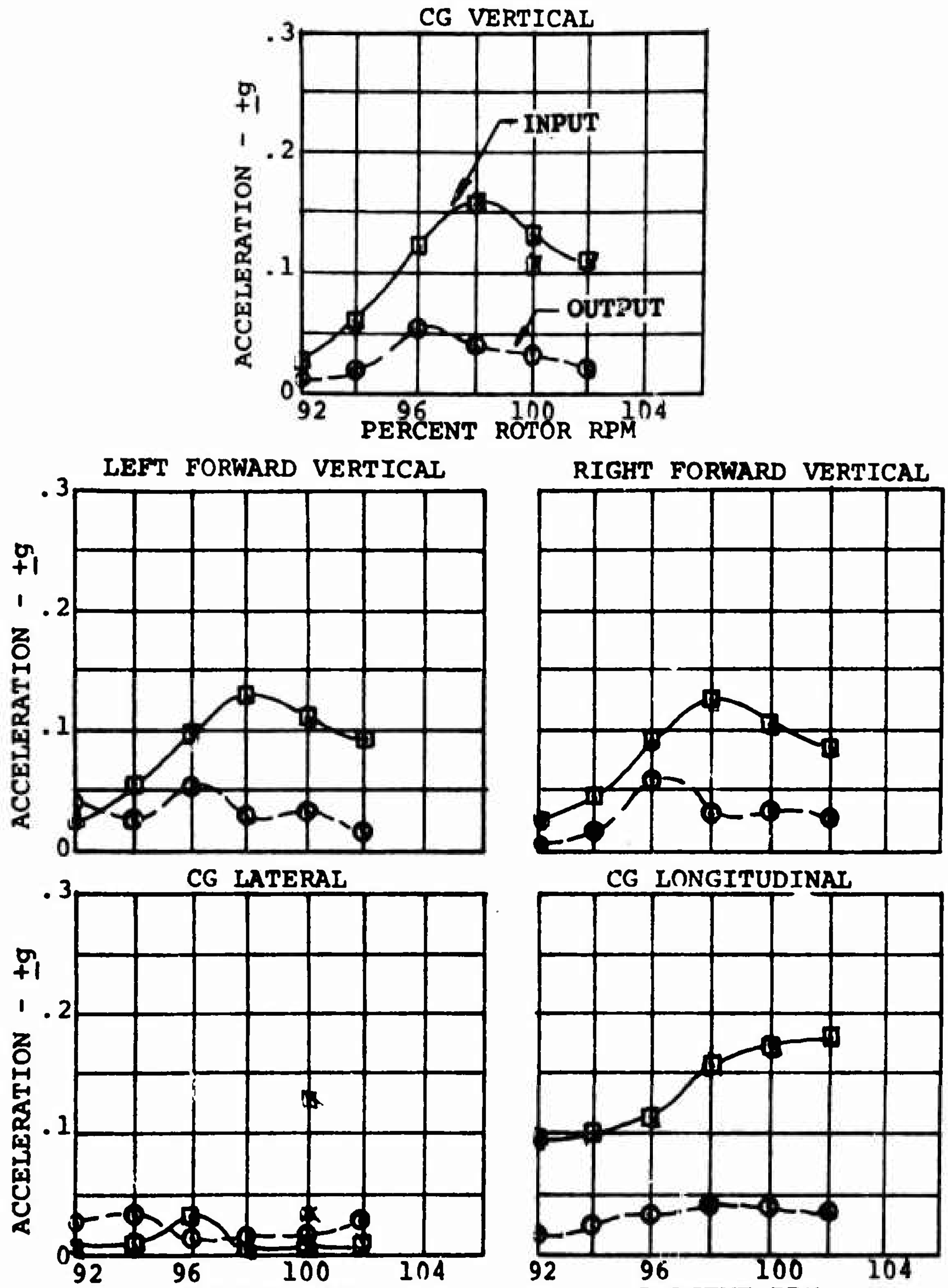


Figure 59. 120-Knot Four-Per-Rev Results of the 200-Pound Conventional Platform.

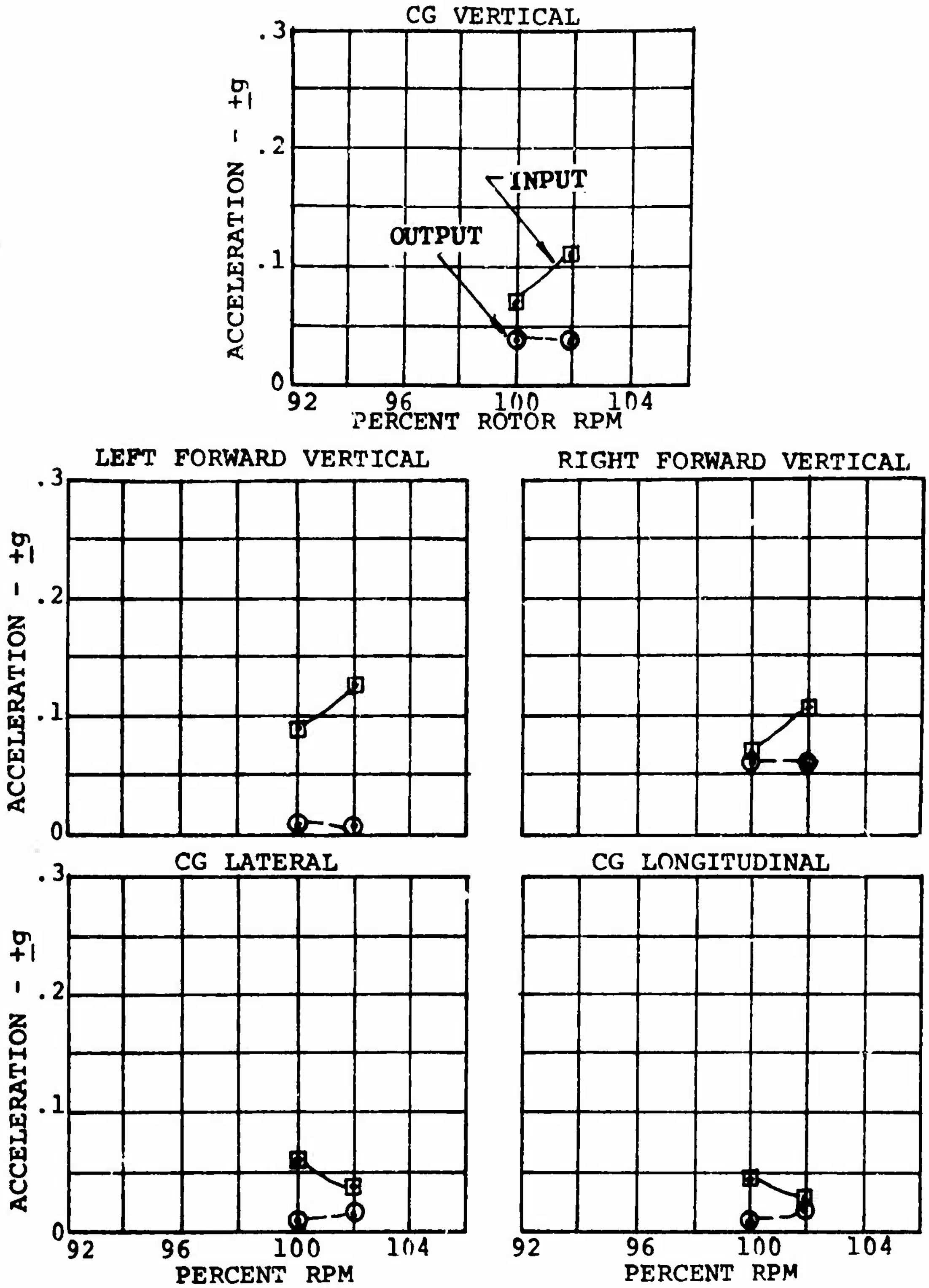


Figure 60. 30-Knot Four-Per-Rev Results of the 200-Pound With a Three-Inch CG Offset Conventional Platform.

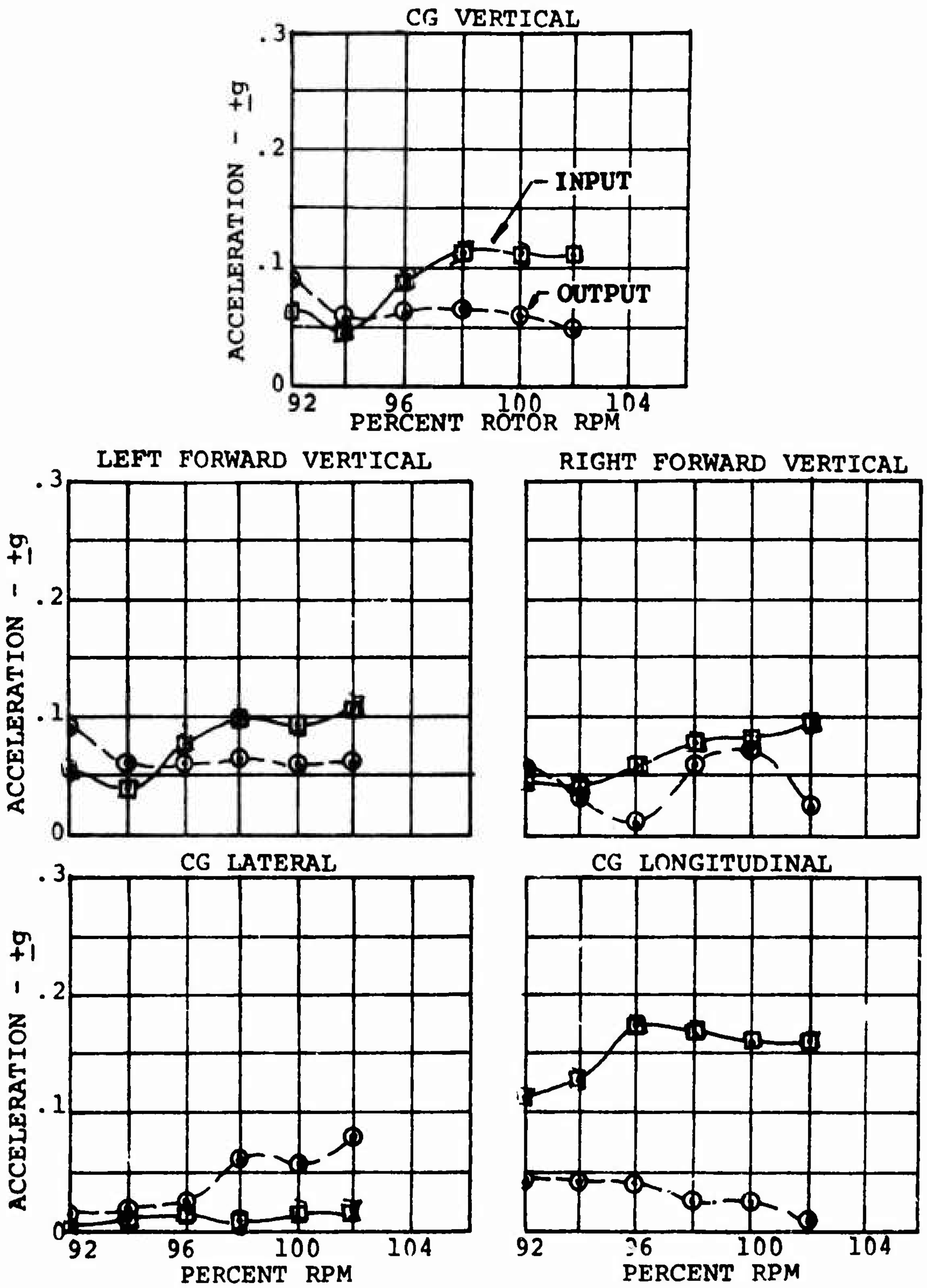


Figure 61. 120-Knot Four-Per-Rev Results of the 200-Pound With a Three-Inch CG Offset Conventional Platform.

TABLE VII. PREDOMINANT VIBRATION LEVELS ON THE CONVENTIONAL PLATFORM

Main Rotor Speed (% RPM)	Pickup Location	Main Rotor Harmonic Vibration Level (Acceleration - ±g) One-Per-Rev Input	One-Per-Rev Output	Eight-Per-Rev Input	Eight-Per-Rev Output
50-Pound Platform - 30 Knots					
	Lft Fwd Vt	.044	.034	.080	.106
	Rt Fwd Vt	.042	.092	.030	.091
94	Center Vt	.039	.048	.055	.070
	Center Lat	.033	.005	.007	.012
	Center Long.	.009	.073	.028	.122
	Lft Fwd Vt	.055	.031	.076	.016
	Rt Fwd Vt	.021	.028	.042	.032
96	Center Vt	.050	.044	.038	.019
	Center Lat	.004	.006	.029	.017
	Center Long.	.004	.004	.008	.012
	Lft Fwd Vt	.031	.038	.070	.013
	Rt Fwd Vt	.026	.034	.057	.006
98	Center Vt	.028	.034	.068	.002
	Center Lat	.003	.006	.030	.004
	Center Long.	.003	.019	.009	.009
	Lft Fwd Vt	.021	.025	.058	.006
	Rt Fwd Vt	.023	.034	.016	.042
100	Center Vt	.031	.029	.016	.059
	Center Lat	.005	.008	.029	.003
	Center Long.	.008	.002	.013	.011
	Lft Fwd Vt	.029	.034	.015	.006
	Rt Fwd Vt	.025	.032	.020	.002
102	Center Vt	.028	.036	.014	.013
	Center Lat	.003	.002	.008	.003
	Center Long.	.008	.013	.016	.002
50-Pound Platform - 120 Knots					
	Lft Fwd Vt	.077	.057	.097	.020
	Rt Fwd Vt	.032	.052	.037	.022
94	Center Vt	.046	.060	.027	.048
	Center Lat	.005	.012	.022	.008
	Center Long.	.014	.015	.049	.017

TABLE VII - Continued					
50-Pound Platform - 120 Knots					
Main Rotor Speed (% RPM)	Pickup Location	Main Rotor Harmonic Vibration Level (Acceleration - ±g)			
		One-Per-Rev		Eight-Per-Rev	
		Input	Output	Input	Output
96	Lft Fwd Vt	.019	.021	.055	.028
	Rt Fwd Vt	.017	.017	.037	.019
	Center Vt	.013	.026	.029	.015
	Center Lat	.002	.010	.025	.032
	Center Long.	.016	.020	.021	.007
98	Lft Fwd Vt	.008	.011	.038	.026
	Rt Fwd Vt	.012	.013	.026	.024
	Center Vt	.011	.025	.032	.032
	Center Lat	.009	.016	.044	.020
	Center Long.	.011	.021	.036	.010
100	Lft Fwd Vt	.036	.039	.029	.029
	Rt Fwd Vt	.030	.042	.018	.013
	Center Vt	.035	.032	.008	.025
	Center Lat	.008	.017	.031	.024
	Center Long.	.018	.020	.015	.006
102	Lft Fwd Vt	.019	.025	.038	.018
	Rt Fwd Vt	.024	.032	.018	.016
	Center Vt	.026	.038	.032	.010
	Center Lat	.002	.008	.031	.014
	Center Long.	.014	.014	.023	.009
150-Pound Platform - 30 Knots					
92	Lft Fwd Vt	.029	.038	.030	.003
	Rt Fwd Vt	.029	.035	.024	.005
	Center Vt	.029	.037	.031	.001
	Center Lat	.001	.003	.003	.001
	Center Long.	.008	.008	.010	.005
94	Lft Fwd Vt	.023	.033	.040	.008
	Rt Fwd Vt	.021	.030	.026	.008
	Center Vt	.022	.027	.044	.006
	Center Lat	.003	.004	.012	.007
	Center Long.	.007	.007	.014	.003

TABLE VII - Continued					
150-Pound Platform - 30 Knots					
Main Rotor Speed (% RPM)	Pickup Location	Main Rotor Harmonic Vibration Level (Acceleration - ±g)			
		One-Per-Rev		Eight-Per-Rev	
		Input	Output	Input	Output
96	Lft Fwd Vt	.010	.014	.019	.004
	Rt Fwd Vt	.009	.018	.021	.005
	Center Vt	.012	.017	.021	.003
	Center Lat	.001	.003	.012	.003
	Center Long.	.010	.008	.007	.004
98	Lft Fwd Vt	.024	.032	.030	.009
	Rt Fwd Vt	.023	.030	.038	.013
	Center Vt	.027	.033	.046	.004
	Center Lat	.003	.002	.014	.001
	Center Long.	.006	.009	.012	.005
100	Lft Fwd Vt	.033	.040	.041	.016
	Rt Fwd Vt	.028	.041	.045	.009
	Center Vt	.032	.043	.053	.004
	Center Lat	.002	.003	.017	.002
	Center Long.	.008	.006	.027	.001
102	Lft Fwd Vt	.039	.055	.043	.009
	Rt Fwd Vt	.037	.054	.042	.010
	Center Vt	.039	.053	.044	.005
	Center Lat	.004	.005	.004	.004
	Center Long.	.008	.007	.047	.003
150-Pound Platform - 120 Knots					
92	Lft Fwd Vt	.010	.012	.039	.023
	Rt Fwd Vt	.012	.016	.037	.011
	Center Vt	.010	.008	.021	.011
	Center Lat	.004	.010	.050	.018
	Center Long.	.006	.011	.058	.008
94	Lft Fwd Vt	.031	.040	.032	.010
	Rt Fwd Vt	.031	.041	.037	.007
	Center Vt	.034	.043	.031	.006
	Center Lat	.009	.013	.022	.012
	Center Long.	.005	.009	.031	.006

TABLE VII - Continued					
150-Pound Platform - 120 Knots					
Main Rotor Speed (% RPM)	Pickup Location	Main Rotor Harmonic Vibration Level (Acceleration - ±g)			
		One-Per-Rev		Eight-Per-Rev	
		Input	Output	Input	Output
96	Lft Fwd Vt	.013	.012	.033	.004
	Rt Fwd Vt	.010	.010	.030	.011
	Center Vt	.012	.013	.034	.006
	Center Lat	.010	.005	.033	.008
	Center Long.	.005	.005	.041	.008
98	Lft Fwd Vt	.033	.041	.030	.007
	Rt Fwd Vt	.034	.046	.040	.012
	Center Vt	.032	.035	.026	.006
	Center Lat	.008	.005	.043	.013
	Center Long.	.013	.023	.036	.002
100	Lft Fwd Vt	.018	.015	.026	.009
	Rt Fwd Vt	.021	.023	.025	.006
	Center Vt	.022	.027	.026	.008
	Center Lat	.003	.007	.019	.004
	Center Long.	.008	.008	.017	.003
102	Lft Fwd Vt	.017	.023	.025	.006
	Rt Fwd Vt	.018	.025	.004	.011
	Center Vt	.018	.022	.018	.003
	Center Lat	.004	.002	.024	.003
	Center Long.	.014	.027	.010	.003
200-Pound Platform - 30 Knots					
92	Lft Fwd Vt	.026	.046	.026	.011
	Rt Fwd Vt	.023	.043	.026	.009
	Center Vt	.025	.041	.033	.007
	Center Lat	.003	.001	.031	.008
	Center Long.	.009	.010	.019	.002
94	Lft Fwd Vt	.033	.045	.066	.016
	Rt Fwd Vt	.032	.045	.044	.013
	Center Vt	.038	.051	.072	.005
	Center Lat	.002	.005	.007	.005
	Center Long.	.012	.011	.015	.005

TABLE VII - Continued					
200-Pound Platform - 30 Knots					
Main Rotor Speed (% RPM)	Pickup Location	Main Rotor Harmonic Vibration Level (Acceleration - ±g)			
		One-Per-Rev		Eight-Per-Rev	
		Input	Output	Input	Output
96	Lft Fwd Vt	.031	.041	.025	.011
	Rt Fwd Vt	.028	.039	.020	.004
	Center Vt	.028	.039	.030	.005
	Center Lat	.001	.005	.016	.007
	Center Long.	.009	.017	.015	.003
98	Lft Fwd Vt	.027	.051	.034	.010
	Rt Fwd Vt	.021	.049	.041	.010
	Center Vt	.024	.056	.045	.002
	Center Lat	.004	.002	.022	.003
	Center Long.	.006	.003	.015	.002
100	Lft Fwd Vt	.034	.043	.027	.013
	Rt Fwd Vt	.030	.044	.024	.011
	Center Vt	.035	.045	.036	.003
	Center Lat	.002	.008	.021	.001
	Center Long.	.010	.024	.013	.004
102	Lft Fwd Vt	.025	.049	.092	.027
	Rt Fwd Vt	.020	.048	.064	.022
	Center Vt	.021	.051	.090	.007
	Center Lat	.006	.011	.025	.001
	Center Long.	.008	.010	.031	.003
200-Pound Platform - 120 Knots					
92	Lft Fwd Vt	.010	.028	.015	.015
	Rt Fwd Vt	.011	.028	.033	.004
	Center Vt	.009	.033	.022	.001
	Center Lat	.013	.010	.029	.010
	Center Long.	.012	.034	.039	.006
94	Lft Fwd Vt	.023	.037	.021	.011
	Rt Fwd Vt	.017	.041	.044	.009
	Center Vt	.023	.041	.038	.001
	Center Lat	.004	.032	.019	.018
	Center Long.	.008	.013	.043	.003

TABLE VII - Continued					
200-Pound Platform - 120 Knots					
Main Rotor Speed (% RPM)	Pickup Location	Main Rotor Harmonic Vibration Level (Acceleration - ±g)			
		One-Per-Rev		Eight-Per-Rev	
		Input	Output	Input	Output
96	Lft Fwd Vt	.010	.016	.033	.017
	Rt Fwd Vt	.007	.015	.054	.016
	Center Vt	.007	.015	.044	.001
	Center Lat	.005	.021	.040	.013
	Center Long.	.010	.021	.036	.002
98	Lft Fwd Vt	.015	.013	.033	.014
	Pt Fwd Vt	.015	.018	.031	.007
	Center Vt	.015	.010	.025	.005
	Center Lat	.002	.020	.040	.005
	Center Long.	.013	.024	.043	.002
100	Lft Fwd Vt	.020	.010	.017	.014
	Rt Fwd Vt	.019	.014	.013	.007
	Center Vt	.021	.016	.016	.003
	Center Lat	.010	.059	.032	.015
	Center Long.	.015	.005	.018	.003
102	Lft Fwd Vt	.038	.064	.032	.008
	Rt Fwd Vt	.033	.070	.027	.014
	Center Vt	.031	.076	.021	.005
	Center Lat	.006	.028	.048	.008
	Center Long.	.007	.028	.023	.004
200-Pound Platform With 3-Inch CG Offset - 30 Knots					
100	Lft Fwd Vt	.027	.028	.045	.011
	Rt Fwd Vt	.024	.023	.035	.003
	Center Vt	.026	.028	.037	.004
	Center Lat	.001	.020	.009	.003
	Center Long.	.004	.008	.014	.002
102	Lft Fwd Vt	.042	.062	.008	.005
	Rt Fwd Vt	.035	.056	.013	.004
	Center Vt	.038	.060	.008	.005
	Center Lat	.002	.026	.010	.002
	Center Long.	.006	.007	.005	.003

TABLE VII - Continued

200-Pound Platform With 3-Inch CG Offset - 120 Knots

Main Rotor Speed (% RPM)	Pickup Location	Main Rotor Harmonic Vibration Level (Acceleration - ±g)			
		One-Per-Rev		Eight-Per-Rev	
		Input	Output	Input	Output
	Lft Fwd Vt	.033	.052	.025	.006
	Rt Fwd Vt	.033	.044	.044	.014
92	Center Vt	.032	.046	.029	.006
	Center Lat	.006	.013	.029	.006
	Center Long.	.007	.020	.062	.007
	Lft Fwd Vt	.021	.031	.009	.003
	Rt Fwd Vt	.026	.040	.035	.014
94	Center Vt	.029	.034	.019	.005
	Center Lat	.004	.011	.035	.007
	Center Long.	.010	.013	.034	.009
	Lft Fwd Vt	.025	.060	.024	.012
	Rt Fwd Vt	.025	.052	.032	.012
96	Center Vt	.022	.056	.025	.005
	Center Lat	.003	.012	.029	.004
	Center Long.	.007	.013	.023	.003
	Lft Fwd Vt	.024	.044	.030	.008
	Rt Fwd Vt	.016	.029	.027	.007
98	Center Vt	.026	.045	.029	.003
	Center Lat	.007	.053	.023	.005
	Center Long.	.008	.030	.033	.006
	Lft Fwd Vt	.019	.086	.031	.002
	Rt Fwd Vt	.016	.058	.027	.004
100	Center Vt	.017	.083	.027	.007
	Center Lat	.002	.032	.035	.006
	Center Long.	.007	.036	.035	.002
	Lft Fwd Vt	.019	.079	.026	.021
	Rt Fwd Vt	.007	.064	.011	.008
102	Center Vt	.009	.068	.011	.012
	Center Lat	.003	.030	.031	.009
	Center Long.	.010	.032	.005	.003

Figures 54 through 61 show the four-per-rev results obtained. The 50-pound platform was essentially in resonance, and large amplification of the vibration input was obtained on the platform. The 150- and the 200-pound platforms had good isolation.

COMPARISON OF THE THREE-DIMENSIONAL AND CONVENTIONAL PLATFORMS

Table VIII shows a comparison of the four-per-rev results obtained on the three-dimensional DAVI and conventional platforms. These results are reported in the form of transmissibilities in which the output accelerations on the platform were divided by the input acceleration to the platform. These results are for the 30 knot flight condition and at essentially the same four-per-rev frequency, which is 98 percent rotor rpm for the three-dimensional DAVI platform and 100 percent rotor rpm for the conventional platform.

It is seen from this table that the largest discrepancy occurred in the 50-pound platform. For the 50-pound three-dimensional DAVI platform, good isolation was obtained, whereas the 50-pound conventional platform was near resonance and amplification occurred. For the other weight configurations of the three-dimensional DAVI and conventional platforms, excellent isolation was obtained. However, in most cases, the three-dimensional DAVI platform had better isolation and was less susceptible to weight change than the conventional platforms.

It is also seen when comparing the three-dimensional DAVI platform (Figures 22 through 37) results with the conventional platform (Figures 54 through 61) results, that the three-dimensional DAVI platform was less susceptible to an rpm and cg change than the conventional platform.

TABLE VIII. COMPARATIVE TRANSMISSIBILITIES OF THREE-DIMENSIONAL DAVI AND CONVENTIONAL ISOLATED PLATFORMS

Platform Weight (lb)	Pickup Location	Transmissibility		
		Three-Dimensional DAVI Platform		Conventional Platform
		Lateral Orientation	Longitudinal Orientation	
50	CG Vt	.27	.16	2.04
	Lft Fwd Vt	.22	.42	1.71
	Rt Fwd Vt	.12	.56	2.42
	CG Lat	.83	1.08	2.02
	CG Long.	.48	.42	1.99
150	CG Vt Rt	.09	.04	.325
	Lft Fwd Vt	.31	.05	.07
	Rt Fwd Vt	.35	.07	.385
	CG Lat	.52	.18	.124
	CG Long.	.18	.16	.301
200	CG Vt	.08	.11	.20
	Lft Fwd Vt	.11	.16	.15
	Rt Fwd Vt	.08	.58	.07
	CG Lat	.38	.38	.36
	CG Long.	.12	.18	.25
200 Offset CG	CG Vt	.18	.12	.46
	Lft Fwd Vt	.34	.11	.08
	Rt Fwd Vt	.28	.38	.88
	CG Lat	.36	.32	.21
	CG Long.	.22	.11	.62

UNIDIRECTIONAL DAVI

UNIDIRECTIONAL DAVI PLATFORM

Several preliminary tests were done to determine the best platform configuration. The first test was done on the 50-pound platform for two center of gravity positions of the platform, as shown in Figure 62.

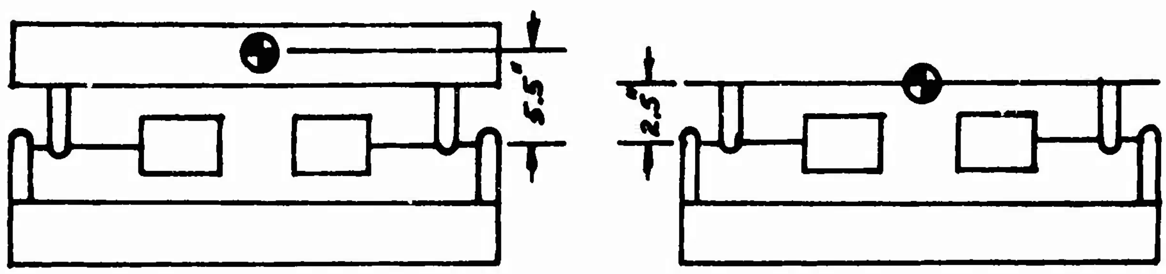
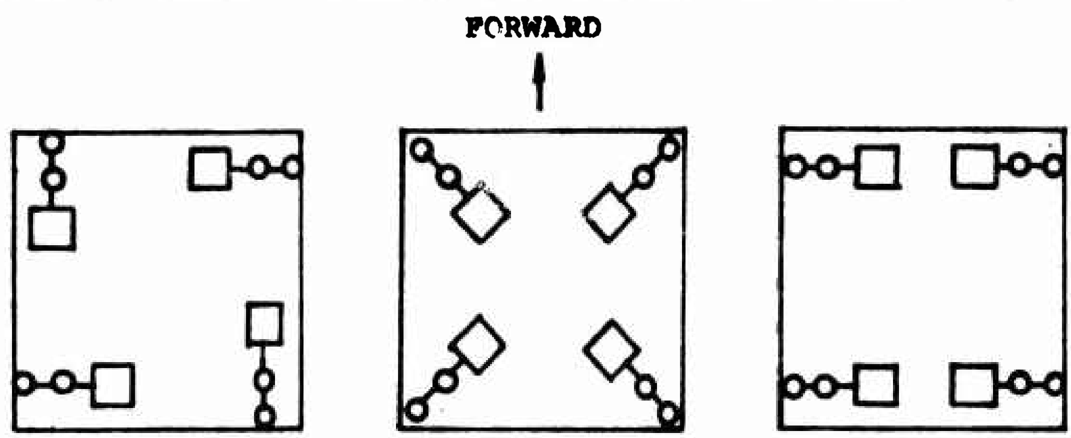


Figure 62. Center of Gravity Position of the Unidirectional Platform.

The preliminary test results indicated that the platform with the reduced height of the center of gravity above the pivots had the minimum vibration level, and this configuration was then used for all of the remaining tests.

Preliminary tests were then done on the 150-pound platform to determine the best orientation of the unidirectional DAVI's. Figure 63 shows the orientations tried.



(a) FIRST ORIENTATION (b) SECOND ORIENTATION (c) THIRD ORIENTATION

Figure 63. Orientation of the Unidirectional DAVI's.

However, the various orientations of the unidirectional DAVI did not have much effect on the vibration level, and the third orientation of the unidirectional DAVI's was used for all the remaining testing.

Figure 64 shows a schematic of the final unidirectional DAVI platform and the location of the ten accelerometers.

Four different weights of the unidirectional DAVI platform were tested: 50 pounds, 150 pounds, 200 pounds, and 200 pounds with a three-inch center of gravity offset in the lateral direction.

The unidirectional DAVI models used in this program were the same ones used in the USAAVLABS program under Contract DA 44-177-AMC-391(T). Figure 65 shows a schematic of this unidirectional DAVI model.

FLIGHT TEST CONDITIONS

The unidirectional DAVI Alpha isolated platform was tested under steady-state or level flight conditions and maneuver conditions. Table IX gives the level flight conditions tested.

TABLE IX. UNIDIRECTIONAL DAVI ISOLATED PLATFORM LEVEL FLIGHT TEST CONDITIONS

Platform Weight (lb)	Platform CG Offset (lb)	Helicopter Gross Weight (lb)	Main Rotor Speed (% RPM)	Airspeed (kn)
50	0	8,500	92	0 to V_H
50	0	8,500	100	0 to V_H
50	0	8,500	92 to 102	30
50	0	8,500	92 to 102	120
150	0	8,500	92	0 to V_H
150	0	8,500	100	0 to V_H
150	0	8,500	92 to 102	30
150	0	8,500	92 to 102	120
200	0	8,500	92	0 to V_H
200	0	8,500	100	0 to V_H
200	0	8,500	92 to 102	30
200	0	8,500	92 to 102	120
200	3	8,500	92	0 to V_H
200	3	8,500	92 to 102	30
200	3	8,500	92 to 102	120
200	3	10,000	92	0 to V_H
200*	3	10,000	100	0 to V_H
200	3	10,000	92 to 102	30
200	3	10,000	92 to 102	105

*This condition was repeated with an out-of-track condition on the main rotor.

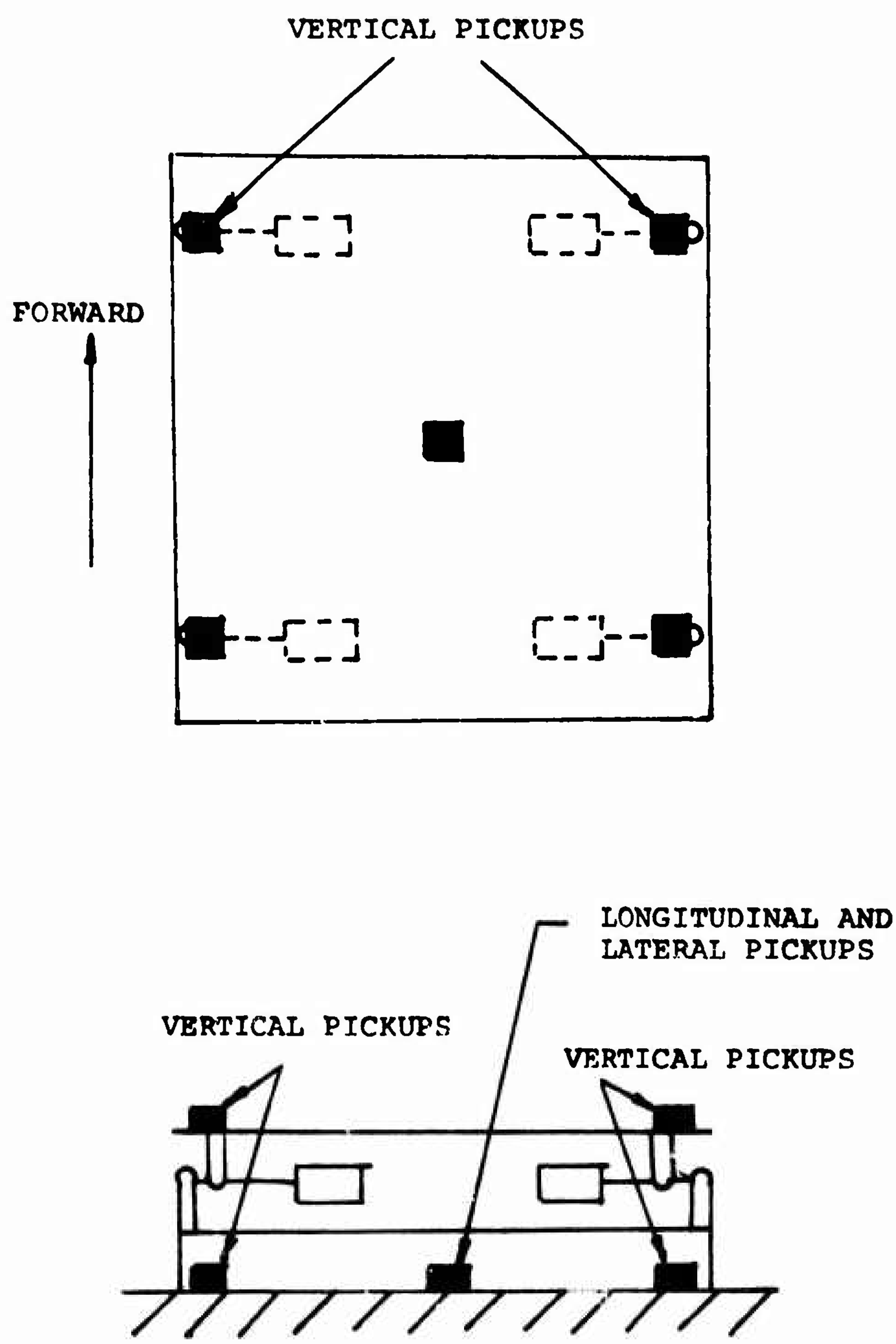


Figure 64. Schematic of the Unidirectional DAVI Platform.

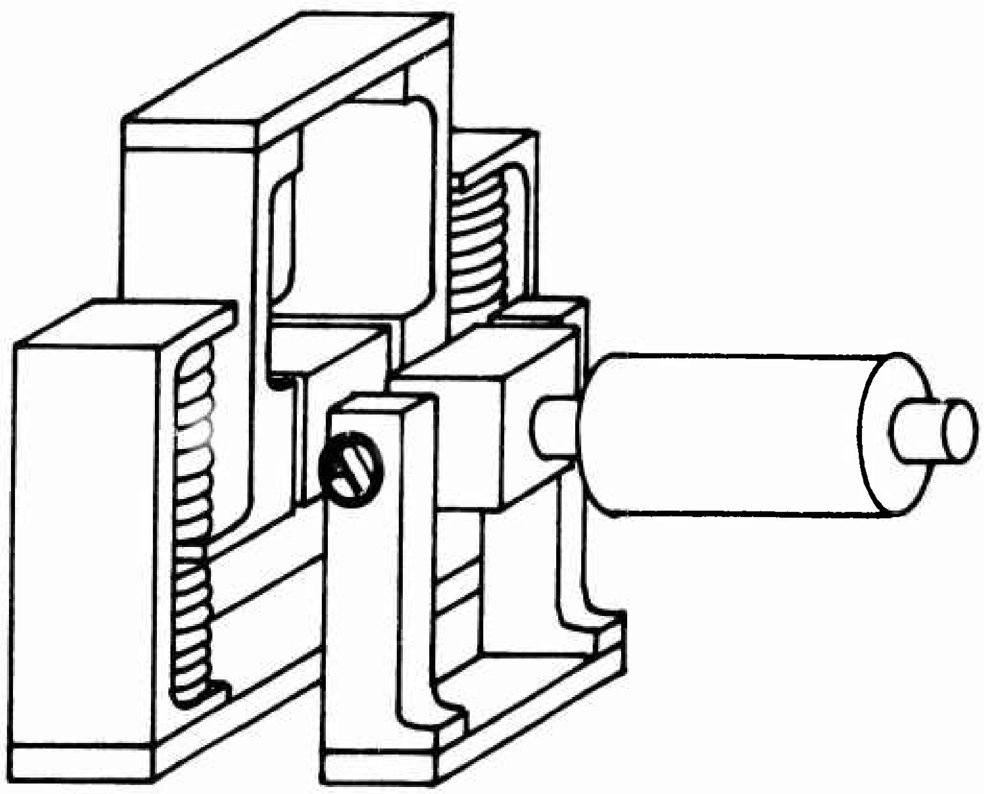


Figure 65. Schematic of the Unidirectional DAVI Model.

Table X gives the maneuver conditions tested on the unidirectional DAVI Alpha platform. These tests were conducted on the 200-pound with a three-inch center of gravity offset platform.

TABLE X. UNIDIRECTIONAL DAVI ISOLATED PLATFORM MANEUVER FLIGHT TEST CONDITIONS

Maneuver	Helicopter Gross Weight (lb)	Main Rotor Speed (% RPM)	Airspeed (kn)
30° bank turn	8500	100	40
30° bank turn	8500	100	100
45° bank turn	8500	100	40
45° bank turn	8500	100	100
2.0 g pullout	8500	100	40
2.0 g pullout	8500	100	100
0.5 g pushover	8500	100	40
0.5 g pushover	8500	100	100
Climb at NRP	8500	100	40
Climb at NRP	8500	100	80
Climb at MRP	8500	100	40
Climb at MRP	8500	100	80
Descent at NRP	8500	100	40
Descent at NRP	8500	100	80
Descent at MRP	8500	100	40
Descent at MRP	8500	100	80
Autorotation	8500	100	60
Landing flare	8500	100	60-0
Hard landings to handbook limit	8500	100	0
Rotor engagement	8500	0-100	Ground

FLIGHT TEST RESULTS

Figures 66 through 69 show typical oscillograph traces obtained in the level flight conditions on the unidirectional DAVI platform for all weight configurations at 30 knots and at 100 percent rotor rpm. At this rotor speed, the predominant four-per-rev excitation most nearly coincides with the tuned antiresonant frequency of the DAVI. For the 50-pound platform, a reduction of vibration was obtained. However, for the other weight configurations, the results are poor.

Figures 70 and 71 show typical oscillograph traces obtained in the transient conditions. No high g level was obtained for these maneuvers.

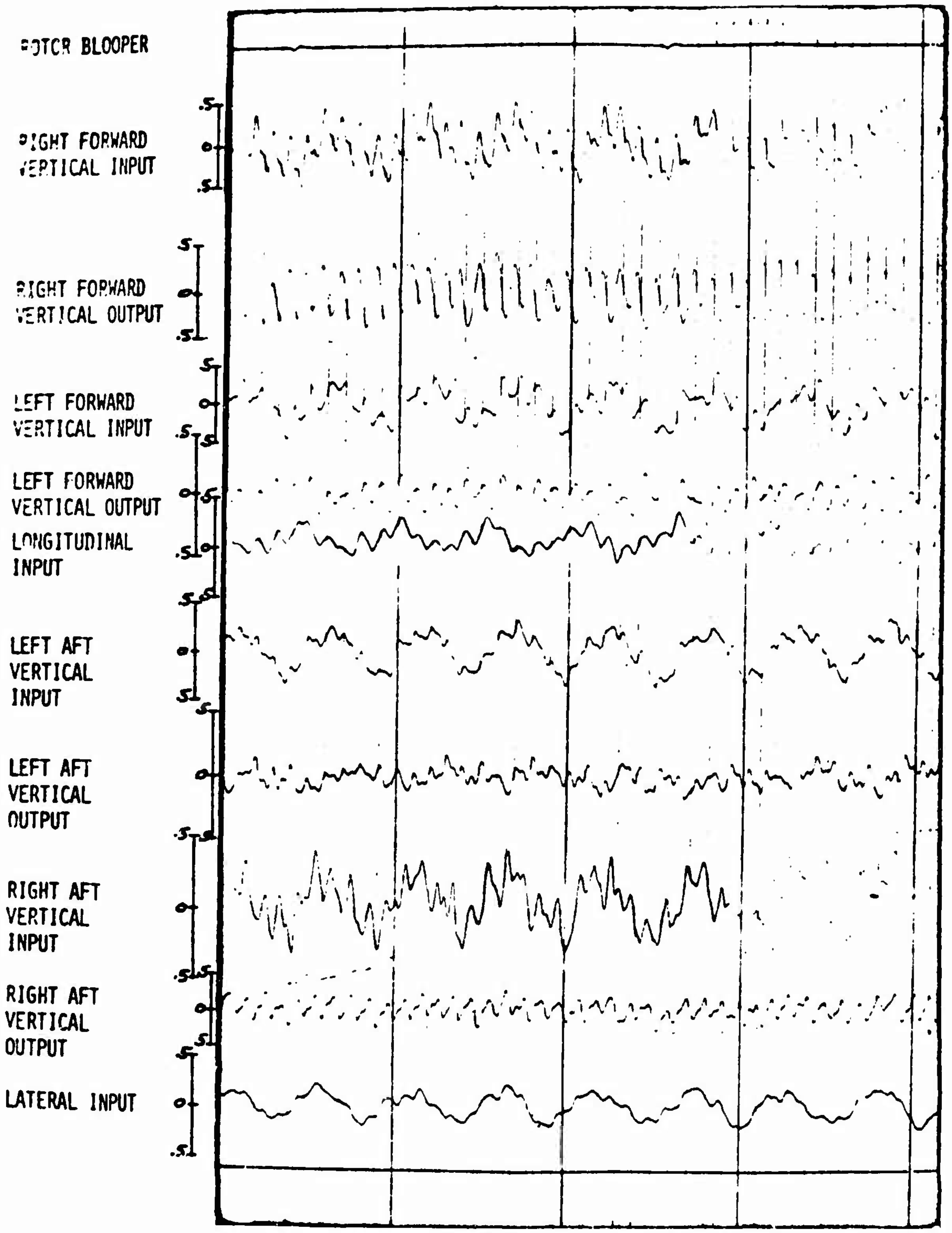


Figure 66. 50-Pound Unidirectional DAVI Platform Level Flight Oscillograph Traces.

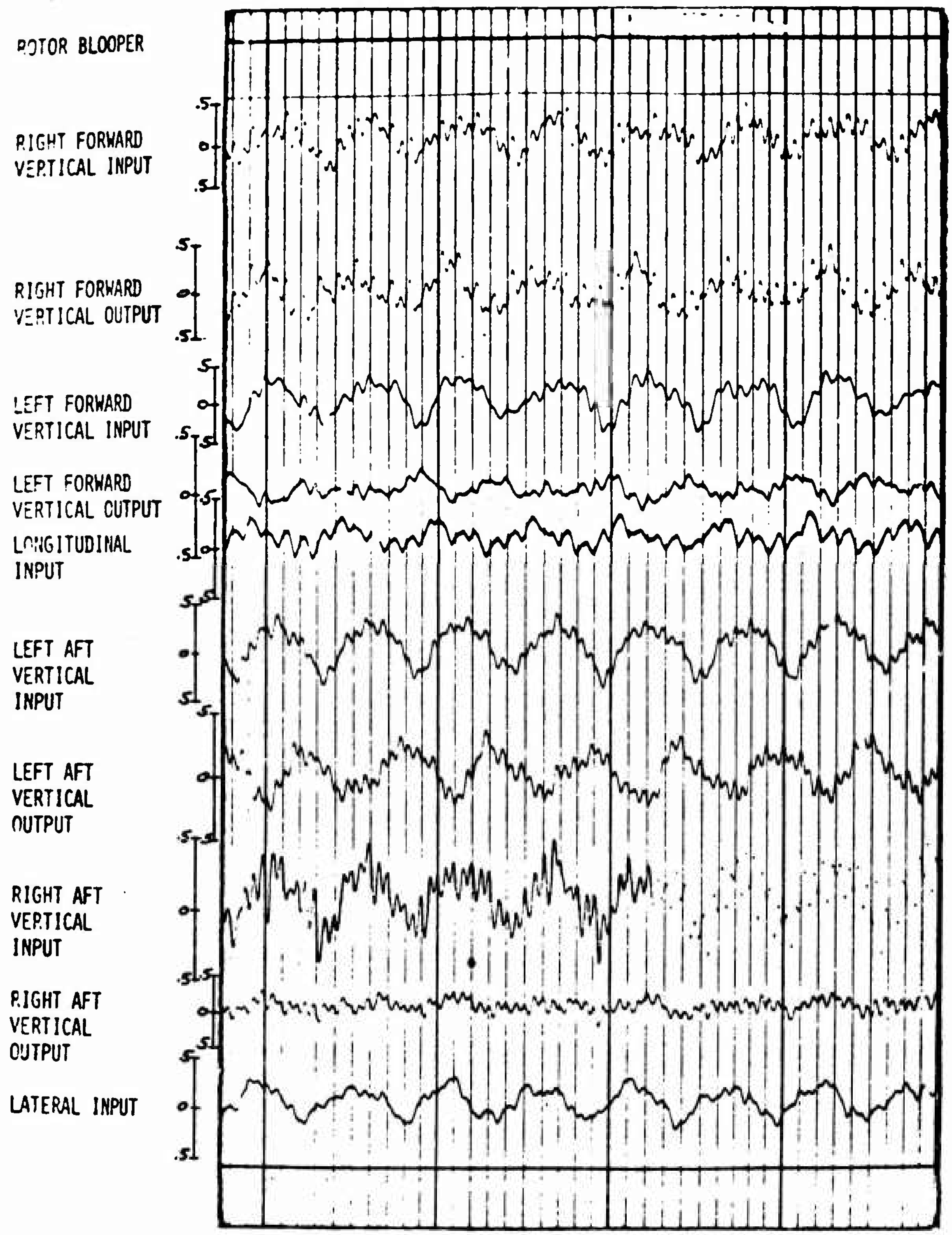


Figure 67. 150-Pound Unidirectional DAVI Platform Level Flight Oscillograph Traces.

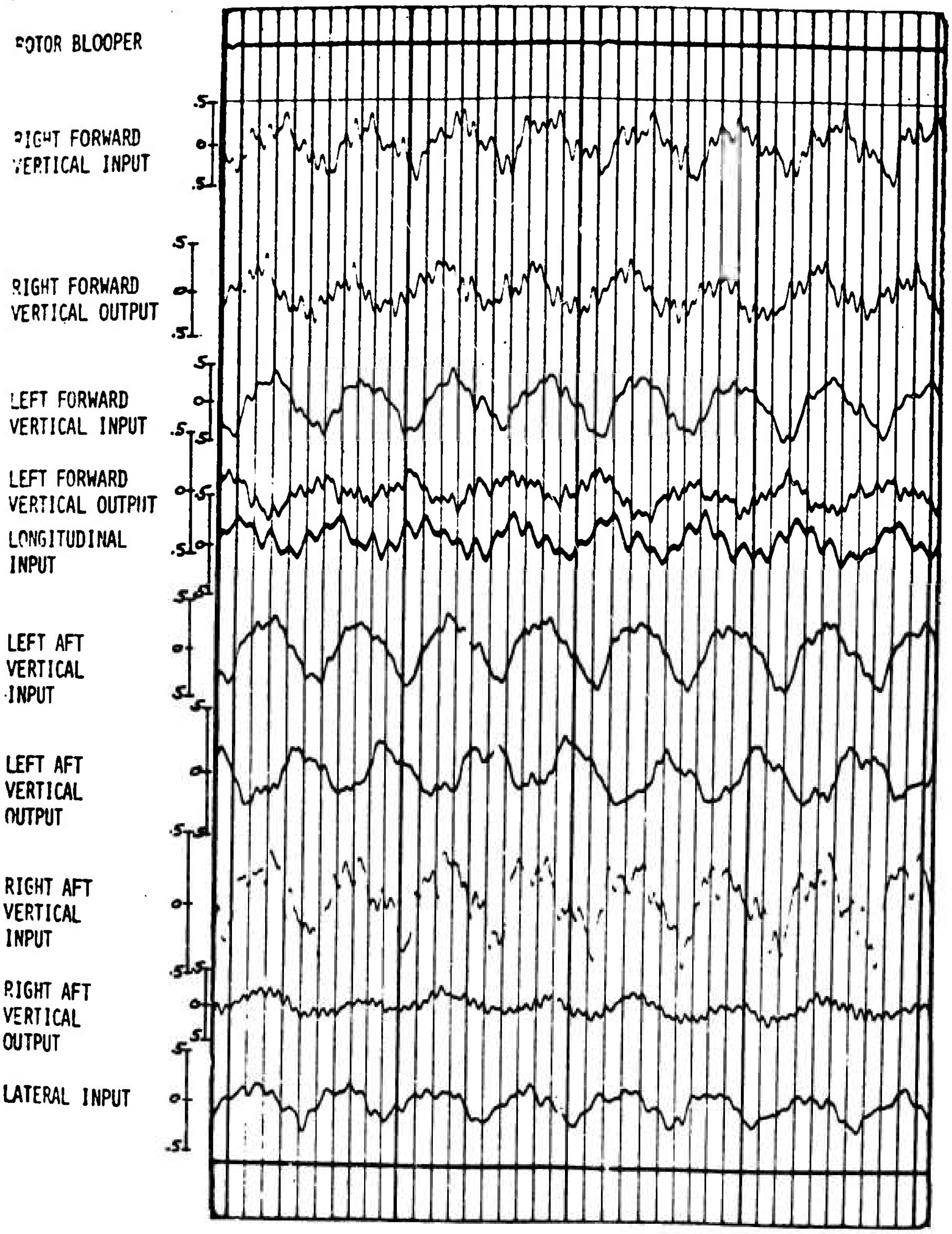


Figure 68. 200-Pound Unidirectional DAVI Platform Level Flight Oscillograph Traces.

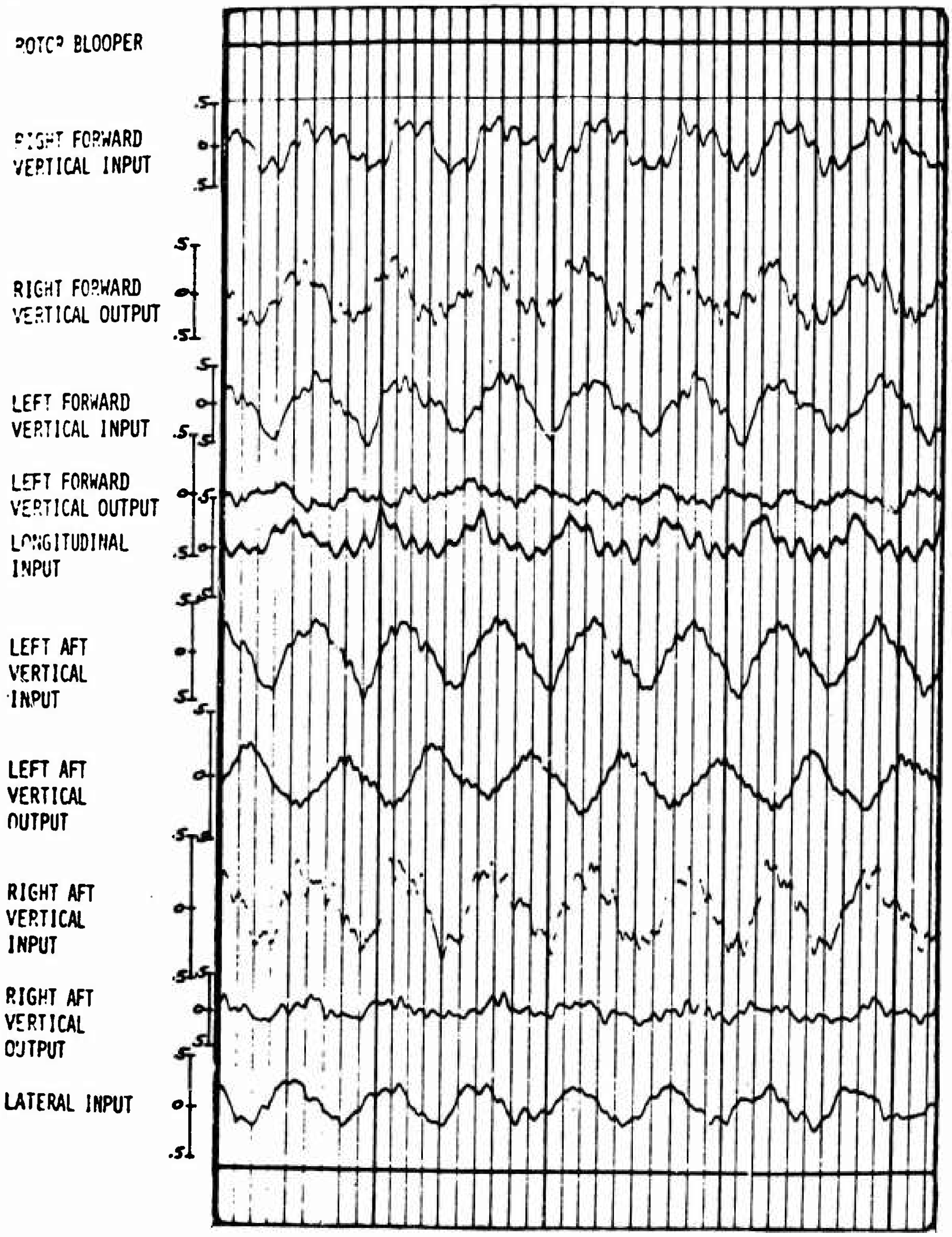


Figure 69. 200-Pound With a Three-Inch CG Offset Unidirectional DAVI Platform Level Flight Oscillograph Traces.

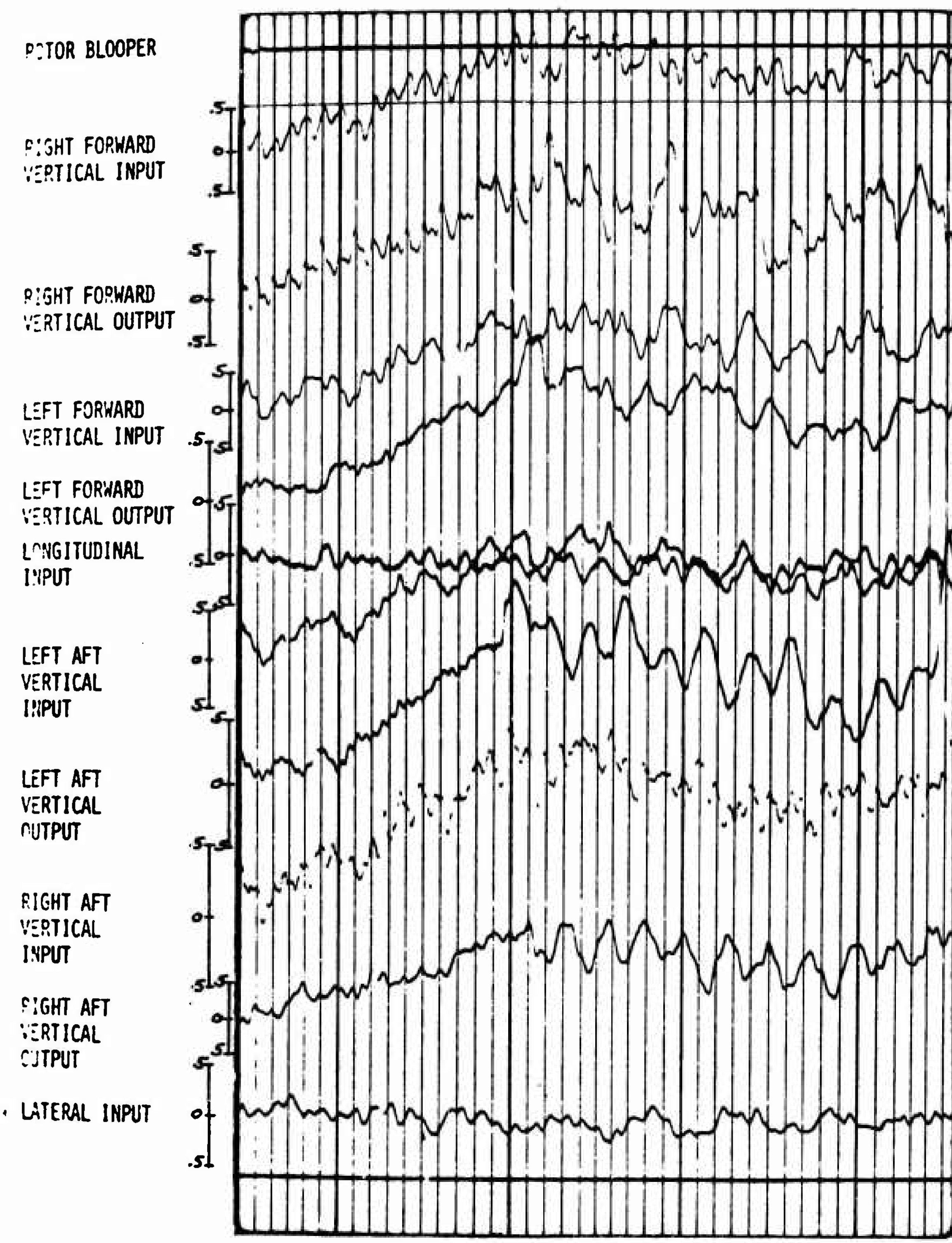


Figure 70. 200-Pound With a Three-Inch CG Offset Unidirectional Platform Oscillograph Traces of a 2g Pullout at 100 Knots.

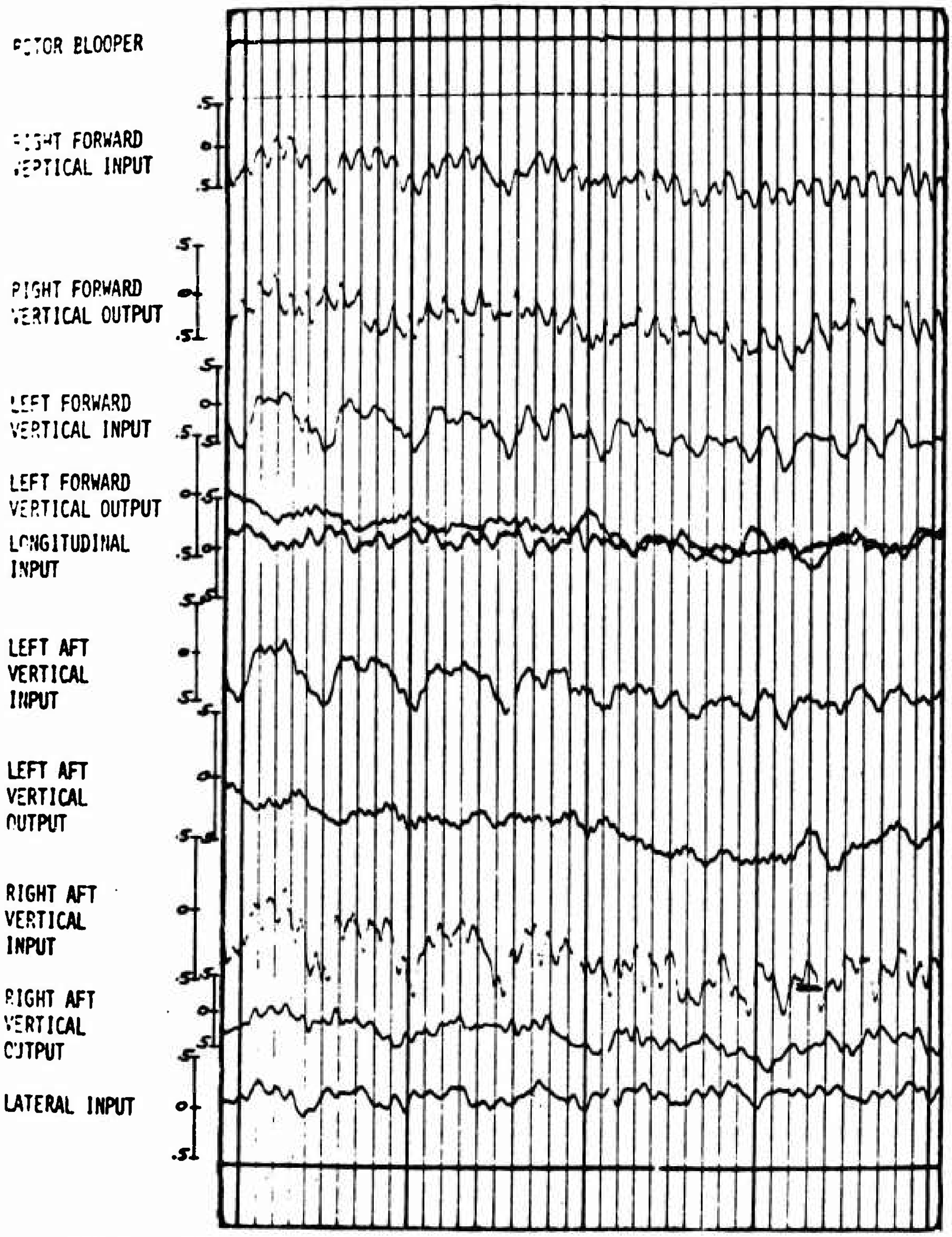


Figure 71. 200-Pound With a Three-Inch CG Offset Unidirectional Platform Oscillograph Traces of a -.5 Pushover at 100 Knots.

A 48-point Fourier analysis was done on the test data to obtain the magnitude of the predominant harmonics. This analysis was done on the test condition that included the rpm sweep from 92 percent to 102 percent of the main rotor at 30 and 120 knots. Table VI gives the frequencies of the predominant harmonics.

The Fourier analysis results are given in Table XI for the one-per-rev and eight-per-rev, and in Figures 72 through 81 for the four-per-rev.

It is seen from Table XI that the one-per-rev vibration levels in most cases are of very low magnitude. In comparing the inputs to the isolated platform with the outputs on the isolated platform, the results are as expected. There is an increase in the one-per-rev vibration level on the isolated platform. However, this increase in vibration level is a minimum. In most cases there is a reduction of eight-per-rev vibration levels on the platform, which is to be expected.

Figures 72 through 81 show the four-per-rev results obtained. Excellent reduction of vibration level was obtained on the unidirectional DAVI 50-pound platform. However, the results obtained on the other weight configurations of the unidirectional platform were poor, and in many cases, amplification of the vibration input to the platform occurred. The primary reason for these poor results is that the unidirectional DAVI platform was designed to isolate in the vertical direction only and is essentially rigid in the lateral and longitudinal directions. However, as seen from the lateral and longitudinal inputs in Figures 66 through 69, the platform was subject to a complex input and not just vertical inputs. This complex input did cause rotation of the platform, and poor vibration characteristics were obtained.

TABLE XI. PREDOMINANT VIBRATION LEVELS ON THE UNIDIRECTIONAL DAVI PLATFORM

50-Pound Platform - 30 Knots

Main Rotor Speed (% RPM)	Pickup Location	Main Rotor Harmonic Vibration Level (Acceleration - ±g) 1 Input	1 Output	8 Input	8 Output
92	Fwd Rt	.020	.013	.099	.037
	Fwd Left	.008	.013	.060	.031
	Aft Left	.020	.023	.073	.017
	Aft Rt	.018	.013	.098	.044
94	Fwd Rt	.011	.033	.106	.038
	Fwd Left	.011	.015	.059	.030
	Aft Left	.020	.015	.080	.024
	Aft Rt	.011	.017	.104	.043
96	Fwd Rt	.027	.028	.105	.061
	Fwd Left	.016	.019	.081	.032
	Aft Left	.018	.022	.102	.047
	Aft Rt	.022	.022	.122	.053
98	Fwd Rt	.016	.018	.161	.019
	Fwd Left	.016	.008	.090	.038
	Aft Left	.005	.008	.043	.045
	Aft Rt	.023	.024	.108	.097
100	Fwd Rt	.015	.028	.071	.011
	Fwd Left	.014	.034	.058	.029
	Aft Left	.021	.022	.038	.032
	Aft Rt	.023	.023	.041	.036
102	Fwd Rt	.046	.026	.111	.025
	Fwd Left	.033	.031	.068	.043
	Aft Left	.020	.033	.042	.048
	Aft Rt	.044	.045	.054	.056

TABLE XI - Continued					
50-Pound Platform - 120 Knots					
Main Rotor Speed (% RPM)	Pickup Location	Main Rotor Harmonic Vibration Level (Acceleration - $\pm g$)			
		1		8	
		Input	Output	Input	Output
92	Fwd Rt	.028	.031	.093	.004
	Fwd Left	.041	.041	.097	.007
	Aft Left	.036	.044	.053	.031
	Aft Rt	.033	.039	.045	.035
94	Fwd Rt	.034	.032	.103	.017
	Fwd Left	.025	.025	.102	.013
	Aft Left	.027	.033	.044	.037
	Aft Rt	.014	.025	.067	.055
96	Fwd Rt	.026	.023	.104	.026
	Fwd Left	.030	.017	.132	.009
	Aft Left	.020	.020	.068	.065
	Aft Rt	.027	.023	.058	.066
98	Fwd Rt	.043	.045	.116	.028
	Fwd Left	.017	.022	.151	.021
	Aft Left	.017	.031	.055	.080
	Aft Rt	.026	.032	.052	.094
100	Fwd Rt	.011	.024	.110	.044
	Fwd Left	.010	.020	.122	.020
	Aft Left	.010	.020	.053	.078
	Aft Rt	.007	.012	.042	.039
102	Fwd Rt	.037	.047	.099	.087
	Fwd Left	.022	.022	.094	.020
	Aft Left	.021	.031	.066	.120
	Aft Rt	.028	.025	.036	.127

TABLE XI - Continued					
150-Pound Platform - 30 Knots					
Main Rotor Speed (% RPM)	Pickup Location	Main Rotor Harmonic Vibration Level (Acceleration - ±g)			
		1		8	
		Input	Output	Input	Output
92	Fwd Rt	.009	.012	.039	.046
	Fwd Left	.008	.008	.161	.049
	Aft Left	.012	.008	.089	.036
	Aft Rt	.016	.015	.066	.024
94	Fwd Rt	.017	.014	.023	.034
	Fwd Left	.013	.010	.114	.043
	Aft Left	.010	.010	.049	.018
	Aft Rt	.011	.019	.029	.019
96	Fwd Rt	.016	.015	.025	.049
	Fwd Left	.013	.024	.148	.028
	Aft Left	.013	.022	.090	.026
	Aft Rt	.018	.022	.068	.010
98	Fwd Rt	.022	.029	.013	.077
	Fwd Left	.023	.025	.125	.029
	Aft Left	.023	.027	.054	.012
	Aft Rt	.023	.030	.042	.013
100	Fwd Rt	.017	.020	.045	.039
	Fwd Left	.017	.021	.065	.010
	Aft Left	.011	.020	.057	.042
	Aft Rt	.018	.021	.025	.007
102	Fwd Rt	.018	.033	.111	.037
	Fwd Left	.017	.023	.130	.026
	Aft Left	.032	.020	.154	.069
	Aft Rt	.024	.034	.148	.025

TABLE XI - Continued

150-Pound Platform - 120 Knots

Main Rotor Speed (% RPM)	Pickup Location	Main Rotor Harmonic Vibration Level (Acceleration - $\pm g$) 1 Input	1 Output	8 Input	8 Output
92	Fwd Rt	.015	.020	.047	.015
	Fwd Left	.023	.032	.025	.014
	Aft Left	.012	.028	.017	.008
	Aft Rt	.010	.013	.024	.011
94	Fwd Rt	.025	.025	.053	.052
	Fwd Left	.031	.044	.124	.053
	Aft Left	.027	.034	.036	.020
	Aft Rt	.012	.026	.015	.016
96	Fwd Rt	.051	.053	.027	.064
	Fwd Left	.043	.051	.120	.040
	Aft Left	.041	.053	.015	.039
	Aft Rt	.038	.063	.025	.024
98	Fwd Rt	.034	.027	.023	.068
	Fwd Left	.033	.033	.102	.038
	Aft Left	.040	.040	.043	.027
	Aft Rt	.015	.016	.020	.022
100	Fwd Rt	.029	.039	.015	.039
	Fwd Left	.020	.041	.022	.009
	Aft Left	.029	.041	.015	.012
	Aft Rt	.023	.031	.012	.032
102	Fwd Rt	.027	.050	.040	.023
	Fwd Left	.025	.048	.053	.020
	Aft Left	.025	.053	.028	.006
	Aft Rt	.031	.048	.041	.014

TABLE XI - Continued					
200-Pound Platform - 30 Knots					
Main Rotor Speed (% RPM)	Pickup Location	Main Rotor Harmonic Vibration Level (Acceleration - $\pm g$)			
		1		8	
		Input	Output	Input	Output
92	Fwd Rt	.014	.015	.070	.022
	Fwd Left	.009	.015	.076	.015
	Aft Left	.008	.014	.090	.023
	Aft Rt	.020	.015	.079	.010
94	Fwd Rt	.023	.031	.044	.029
	Fwd Left	.022	.026	.114	.023
	Aft Left	.016	.024	.091	.018
	Aft Rt	.030	.032	.060	.055
96	Fwd Rt	.010	.027	.023	.026
	Fwd Left	.017	.019	.090	.029
	Aft Left	.014	.026	.073	.007
	Aft Rt	.019	.024	.056	.007
98	Fwd Rt	.022	.026	.040	.036
	Fwd Left	.012	.016	.077	.016
	Aft Left	.014	.015	.054	.011
	Aft Rt	.014	.020	.068	.016
100	Fwd Rt	.027	.047	.028	.025
	Fwd Left	.024	.036	.068	.007
	Aft Left	.028	.038	.071	.018
	Aft Rt	.030	.044	.059	.013
102	Fwd Rt	.018	.040	.048	.013
	Fwd Left	.022	.029	.068	.019
	Fwd Left	.026	.025	.058	.025
	Aft Rt	.018	.039	.059	.011

TABLE XI - Continued					
200-Pound Platform - 120 Knots					
Main Rotor Speed (% RPM)	Pickup Location	Main Rotor Harmonic Vibration Level (Acceleration - ±g)			
		1		8	
		Input	Output	Input	Output
92	Fwd Rt	.038	.059	.039	.043
	Fwd Left	.038	.048	.044	.044
	Aft Left	.039	.044	.015	.022
	Aft Rt	.038	.049	.018	.009
94	Fwd Rt	.023	.032	.018	.037
	Fwd Left	.031	.056	.070	.050
	Aft Left	.027	.052	.042	.009
	Aft Rt	.017	.033	.020	.008
96	Fwd Rt	.015	.018	.017	.050
	Fwd Left	.020	.007	.072	.045
	Aft Left	.015	.011	.039	.012
	Aft Rt	.020	.021	.016	.002
98	Fwd Rt	.020	.015	.031	.042
	Fwd Left	.023	.002	.071	.041
	Aft Left	.024	.008	.019	.024
	Aft Rt	.020	.011	.018	.009
100	Fwd Rt	.035	.040	.014	.012
	Fwd Left	.038	.058	.014	.023
	Aft Left	.036	.061	.019	.009
	Aft Rt	.031	.044	.023	.015
102	Fwd Rt	.034	.043	.029	.036
	Fwd Left	.044	.075	.055	.043
	Aft Left	.039	.077	.033	.031
	Aft Rt	.032	.034	.030	.024

TABLE XI - Continued					
200-Pound Platform With Offset CG - 30 Knots					
Main Rotor Speed (% RPM)	Pickup Location	Main Rotor Harmonic Vibration Level (Acceleration - ±g)			
		1		8	
		Input	Output	Input	Output
92	Fwd Rt	.018	.029	.011	.036
	Fwd Left	.024	.049	.067	.022
	Aft Left	.019	.032	.045	.010
	Aft Rt	.022	.022	.034	.006
94	Fwd Rt	.023	.024	.071	.038
	Fwd Left	.030	.045	.104	.013
	Aft Left	.020	.036	.095	.014
	Aft Rt	.027	.026	.079	.014
96	Fwd Rt	.008	.018	.084	.055
	Fwd Left	.016	.019	.145	.015
	Aft Left	.012	.014	.123	.023
	Aft Rt	.019	.021	.104	.009
98	Fwd Rt	.010	.024	.045	.045
	Fwd Left	.015	.059	.102	.016
	Aft Left	.021	.061	.077	.021
	Aft Rt	.009	.022	.072	.009
100	Fwd Rt	.020	.018	.051	.012
	Fwd Left	.008	.046	.041	.010
	Aft Left	.017	.054	.054	.018
	Aft Rt	.009	.031	.052	.003
102	Fwd Rt	.024	.021	.078	.090
	Fwd Left	.018	.032	.177	.040
	Aft Left	.022	.034	.118	.044
	Aft Rt	.019	.019	.136	.041

TABLE XI - Continued					
200-Pound Platform With Offset CG - 120 Knots					
Main Rotor Speed (% RPM)	Pickup Location	Main Rotor Harmonic Vibration Level (Acceleration - ±g)			
		1		8	
		Input	Output	Input	Output
92	Fwd Rt	.016	.022	.019	.036
	Fwd Left	.019	.016	.056	.020
	Aft Left	.014	.016	.036	.003
	Aft Rt	.010	.029	.019	.008
94	Fwd Rt	.036	.049	.023	.028
	Fwd Left	.046	.065	.040	.041
	Aft Left	.043	.073	.035	.008
	Aft Rt	.036	.057	.009	.009
96	Fwd Rt	.018	.031	.051	.059
	Fwd Left	.032	.039	.083	.032
	Aft Left	.028	.043	.053	.006
	Aft Rt	.024	.030	.042	.010
98	Fwd Rt	.041	.045	.017	.043
	Fwd Left	.032	.068	.062	.034
	Aft Left	.036	.071	.020	.019
	Aft Rt	.023	.044	.023	.016
100	Fwd Rt	.060	.076	.016	.040
	Fwd Left	.065	.087	.070	.027
	Aft Left	.063	.096	.029	.018
	Aft Rt	.063	.079	.018	.020
102	Fwd Rt	.047	.035	.028	.041
	Fwd Left	.035	.034	.034	.020
	Aft Left	.039	.051	.022	.020
	Aft Rt	.030	.048	.028	.023

TABLE XI - Continued					
200-Pound Platform With Offset CG - 30 Knots*					
Main Rotor Speed (% RPM)	Pickup Location	Main Rotor Harmonic Vibration Level (Acceleration - ±g)			
		1		8	
		Input	Output	Input	Output
92	Fwd Rt	.020	.025	.048	.039
	Fwd Left	.025	.023	.094	.017
	Aft Left	.021	.021	.077	.013
	Aft Rt	.021	.027	.058	.015
94	Fwd Rt	.020	.018	.069	.007
	Fwd Left	.016	.022	.075	.014
	Aft Left	.021	.018	.098	.006
	Aft Rt	.022	.022	.069	.012
96	Fwd Rt	.029	.019	.068	.042
	Fwd Left	.021	.019	.121	.019
	Aft Left	.029	.028	.092	.003
	Aft Rt	.021	.018	.079	.007
98	Fwd Rt	.030	.027	.078	.026
	Fwd Left	.021	.056	.089	.017
	Aft Left	.022	.069	.086	.025
	Aft Rt	.017	.044	.088	.009
100	Fwd Rt	.033	.010	.094	.026
	Fwd Left	.001	.030	.101	.026
	Aft Left	.016	.020	.103	.022
	Aft Rt	.014	.014	.082	.007
102	Fwd Rt	.006	.018	.081	.042
	Fwd Left	.012	.011	.122	.019
	Aft Left	.006	.012	.108	.033
	Aft Rt	.016	.012	.111	.017

*Overload Gross Weight

TABLE XI - Continued					
200-Pound Platform With Offset CG - 105 Knots*					
Main Rotor Speed (% RPM)	Pickup Location	Main Rotor Harmonic Vibration Level (Acceleration - ±g)			
		1		8	
		Input	Output	Input	Output
92	Fwd Rt	.031	.039	.039	.028
	Fwd Left	.029	.059	.071	.015
	Aft Left	.029	.056	.084	.019
	Aft Rt	.023	.028	.061	.019
94	Fwd Rt	.016	.018	.021	.017
	Fwd Left	.011	.029	.069	.008
	Aft Left	.010	.028	.063	.019
	Aft Rt	.016	.022	.051	.011
96	Fwd Rt	.042	.037	.071	.022
	Fwd Left	.027	.081	.078	.007
	Aft Left	.043	.092	.088	.018
	Aft Rt	.033	.050	.085	.005
98	Fwd Rt	.010	.007	.053	.030
	Fwd Left	.020	.046	.089	.018
	Aft Left	.014	.037	.085	.020
	Aft Rt	.008	.009	.060	.043
100	Fwd Rt	.039	.031	.071	.009
	Fwd Left	.031	.047	.068	.017
	Aft Left	.029	.055	.067	.019
	Aft Rt	.033	.033	.073	.032
102	Fwd Rt	.015	.009	.027	.019
	Fwd Left	.015	.027	.074	.011
	Aft Left	.021	.029	.064	.032
	Aft Rt	.004	.016	.051	.004

*Overload Gross Weight

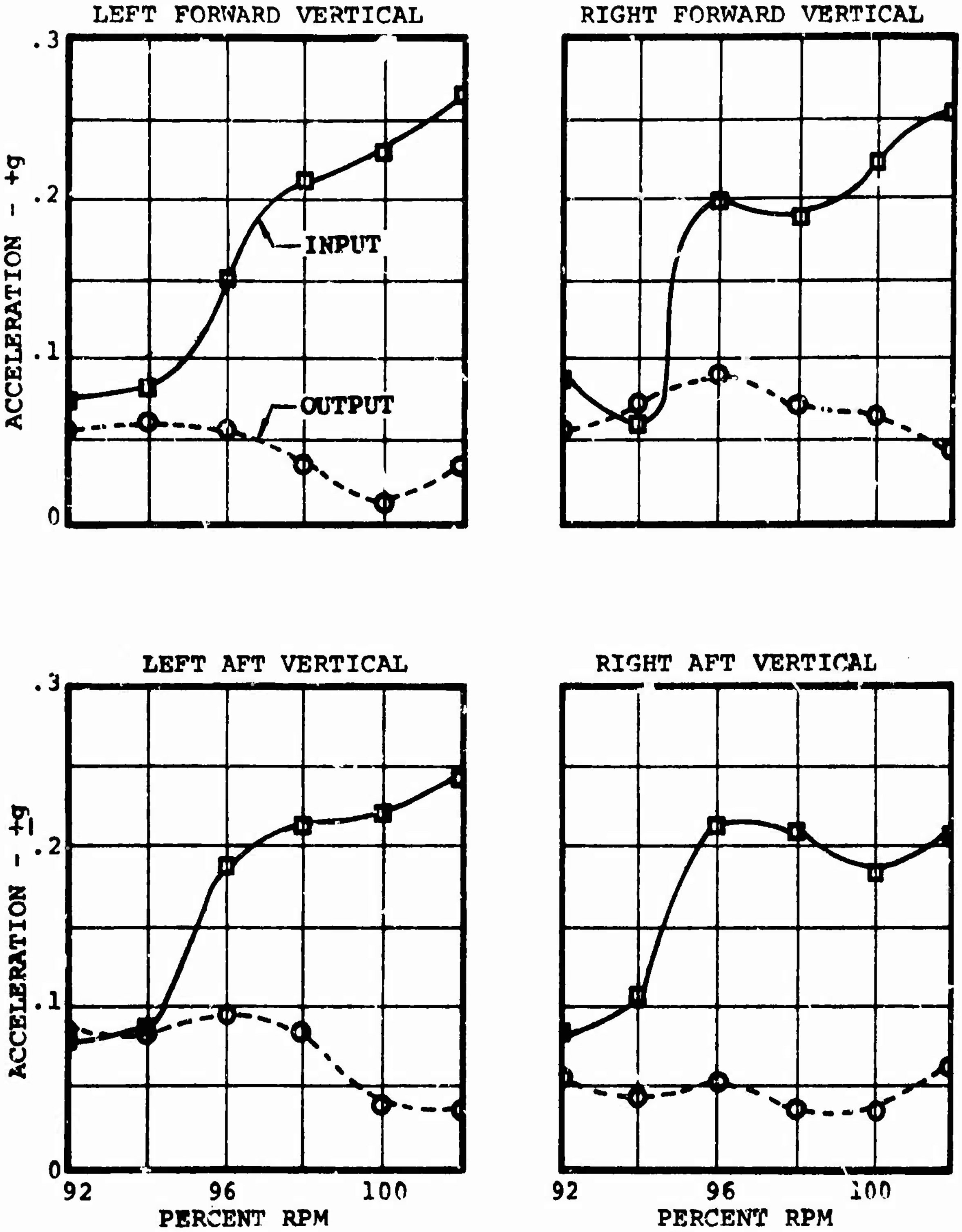


Figure 72. 30-Knot Four-Per-Rev Results of the 50-Pound Unidirectional DAVI Platform.

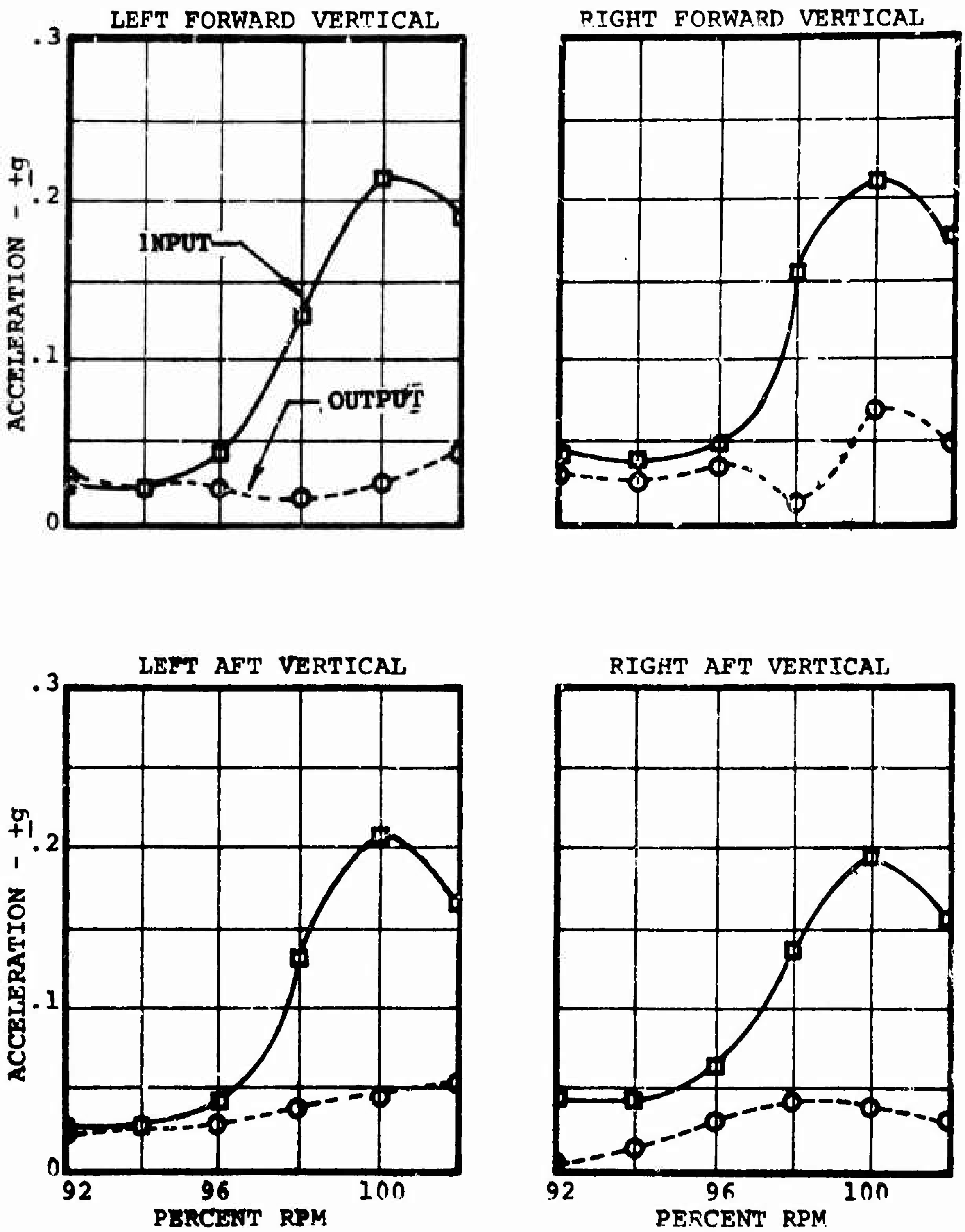


Figure 73. 120-Knot Four-Per-Rev Results of the 50-Pound Unidirectional DAVI Platform.

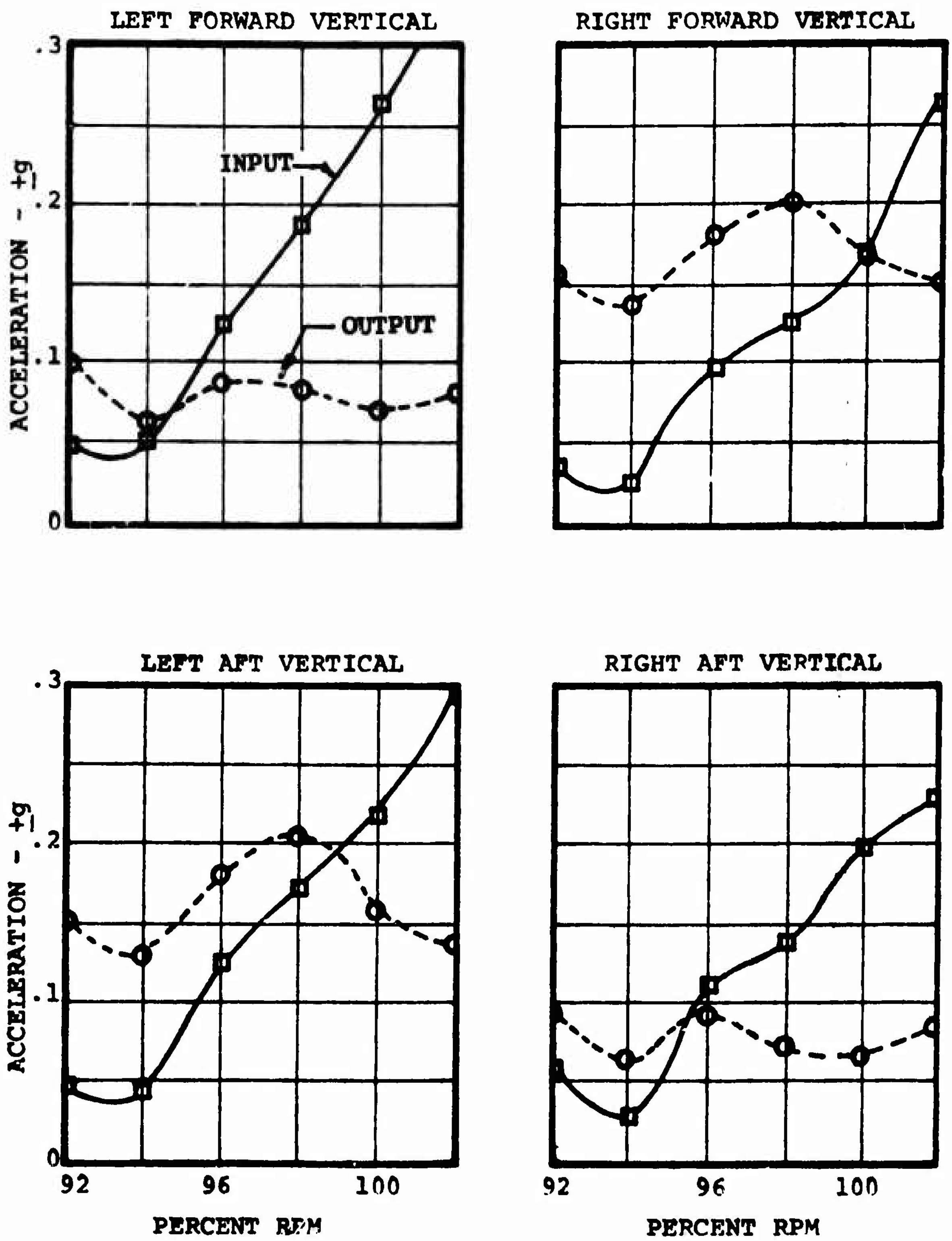


Figure 74. 30-Knot Four-Per-Rev Results of the 150-Pound Unidirectional DAVI Platform.

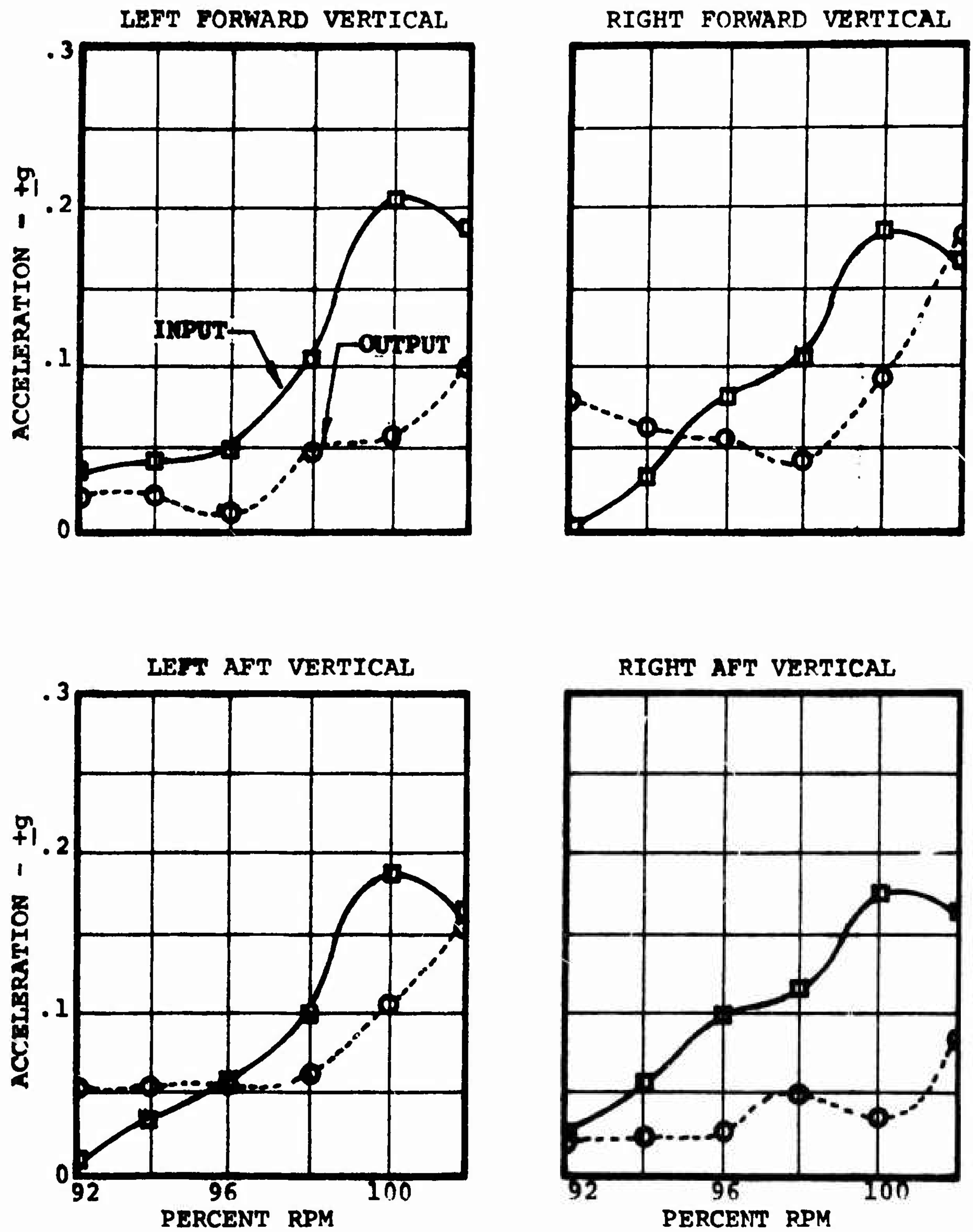


Figure 75. 120-Knot Four-Per-Rev Results of the 150-Pound Unidirectional DAVI Platform.

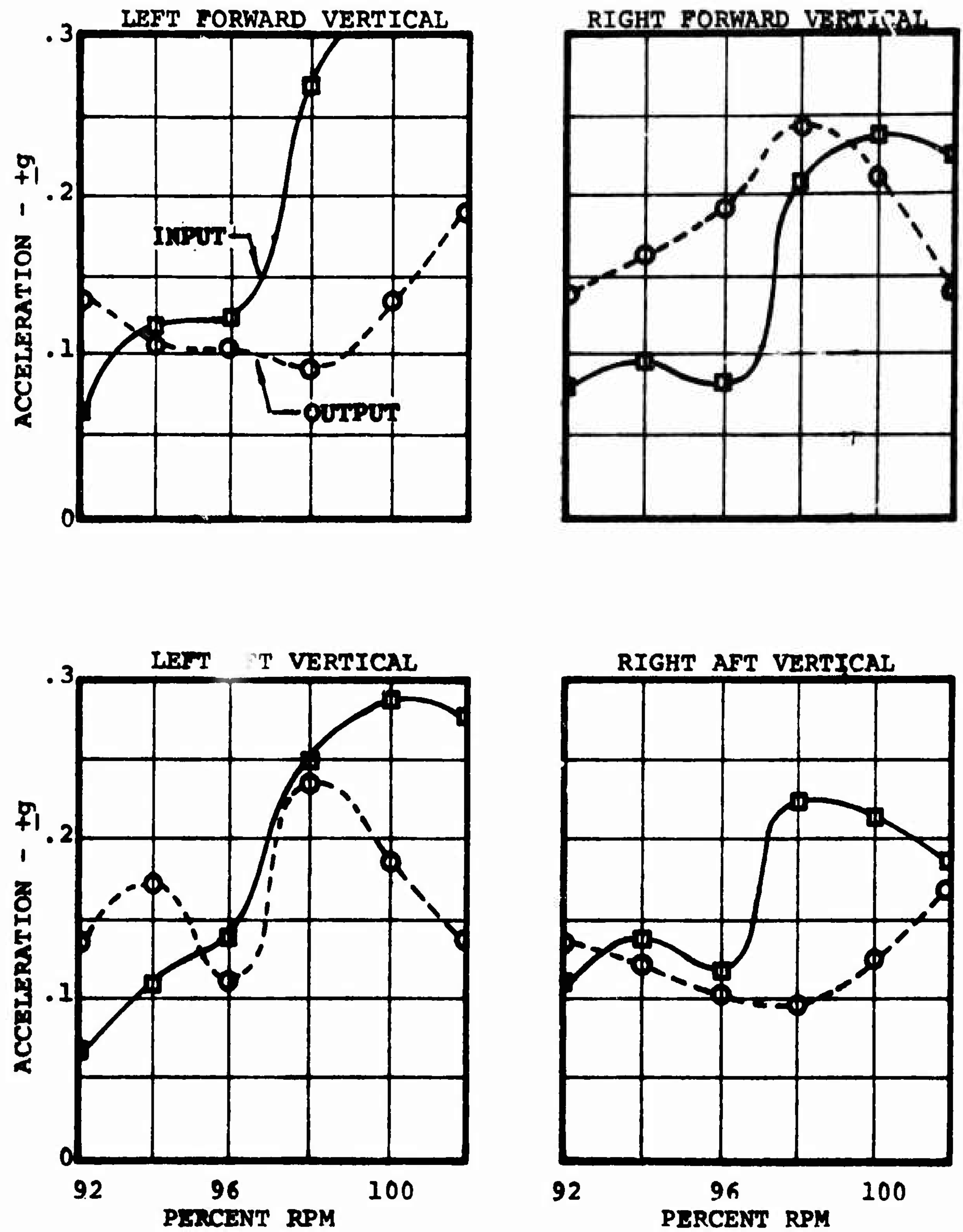


Figure 76. 30-Knot Four-Per-Rev Results of the 200-Pound Unidirectional DAVI Platform.

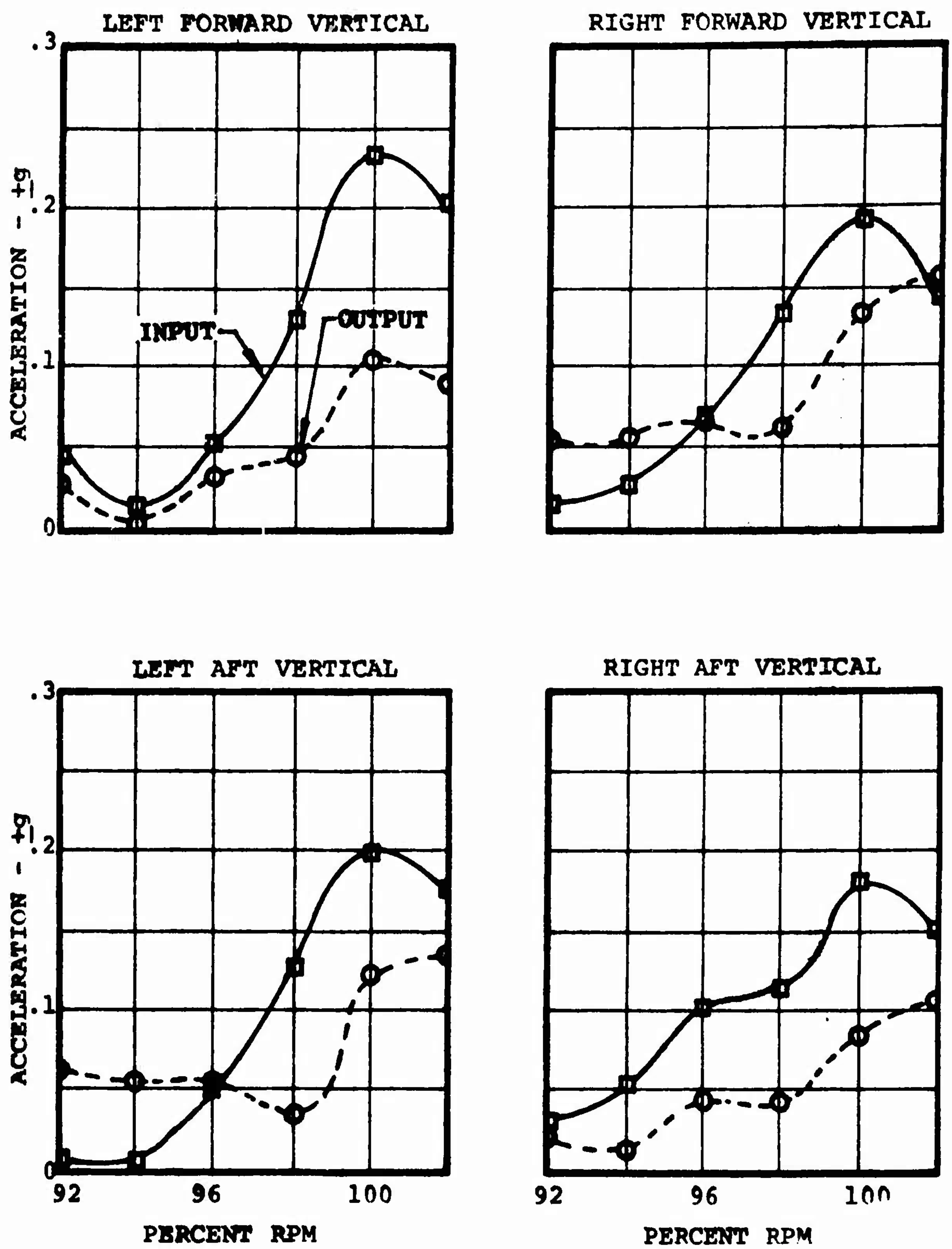


Figure 77. 120-Knot Four-Per-Rev Results of the 200-Pound Unidirectional DAVI Platform.

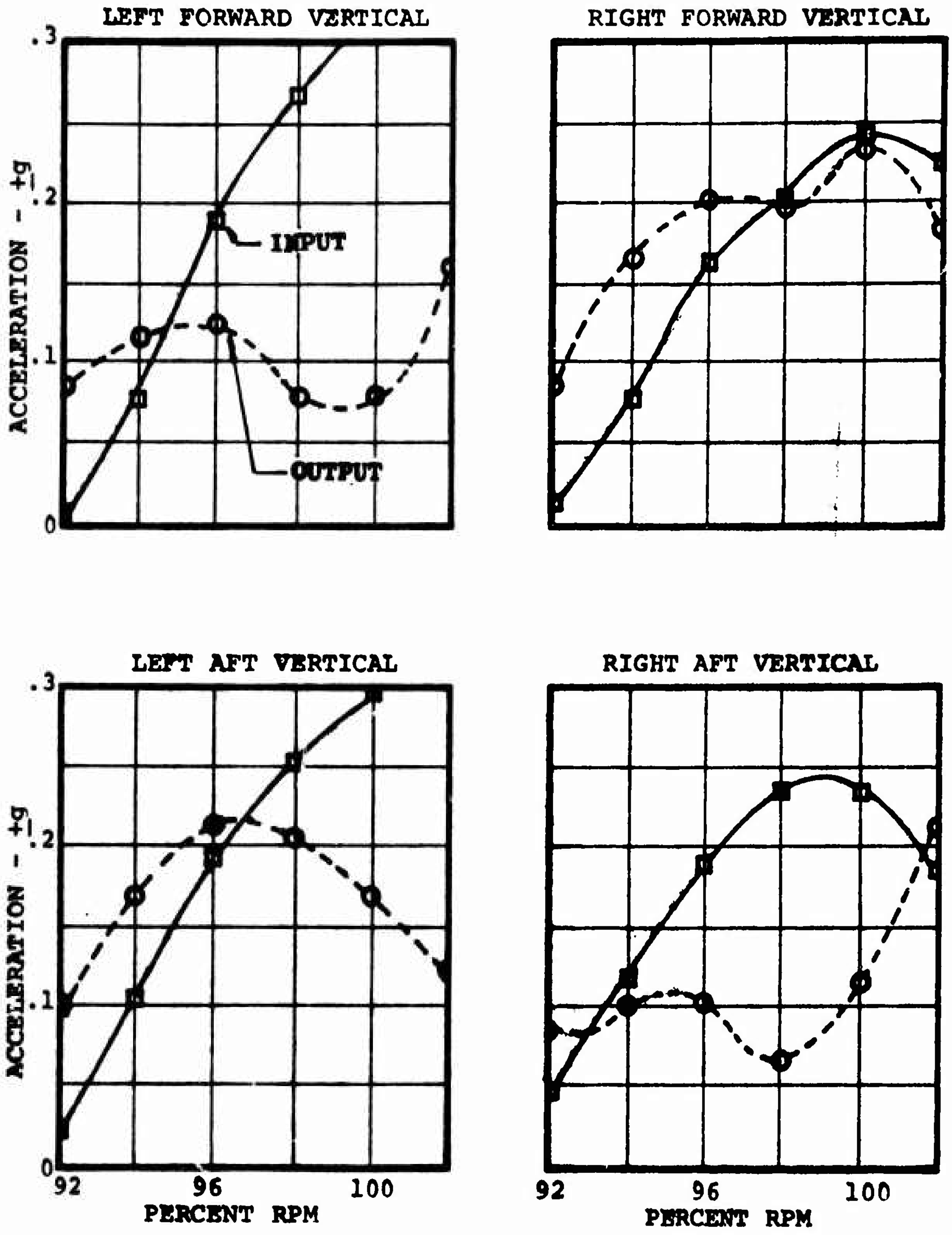


Figure 78. 30-Knot Four-Per-Rev Results of the 240-Pound With a Three-Inch CG Offset Unidirectional DAVI Platform.

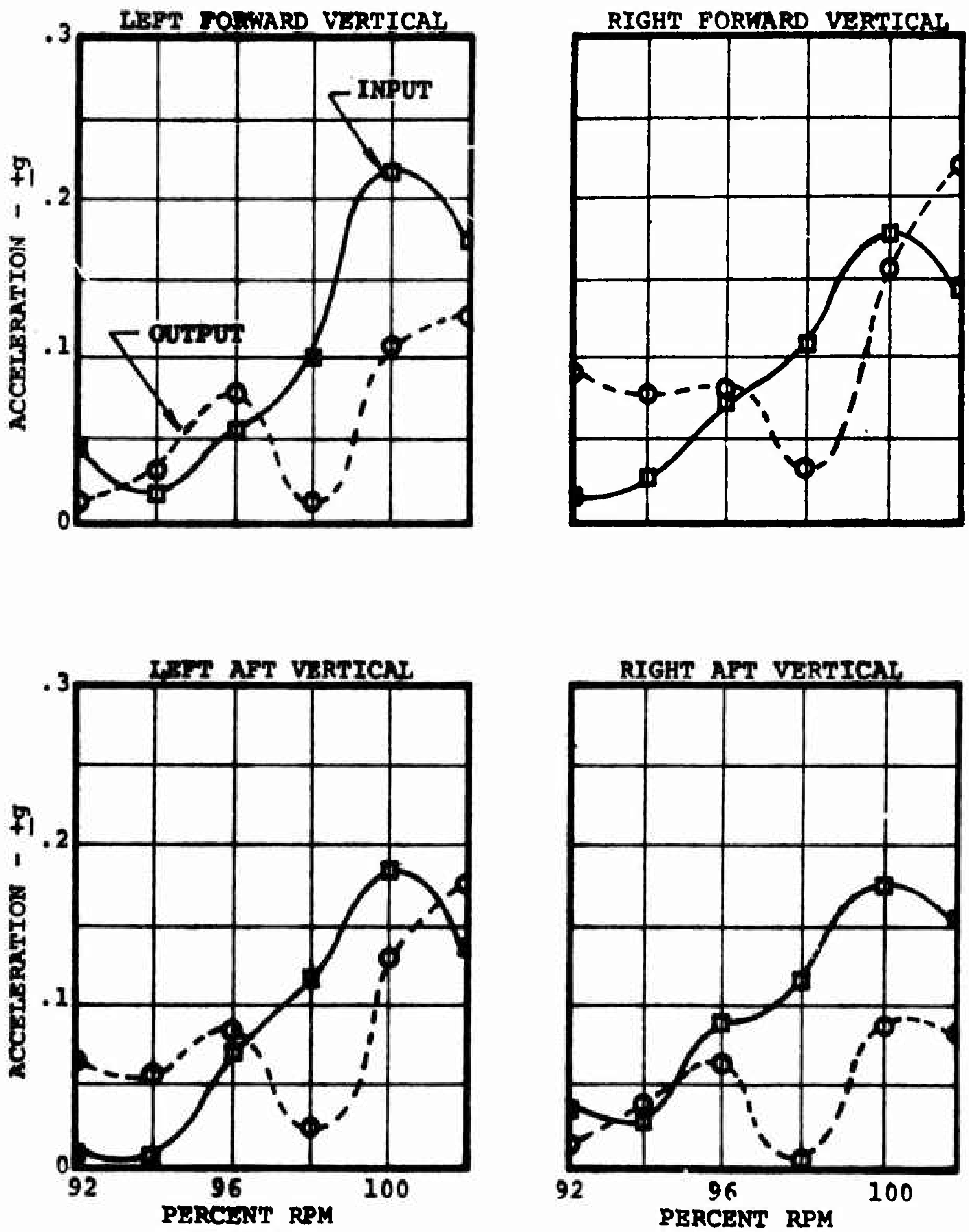


Figure 79. 120-Knot Four-Per-Rev Results of the 200-Pound With a Three-Inch CG Offset Unidirectional DAVI Platform.

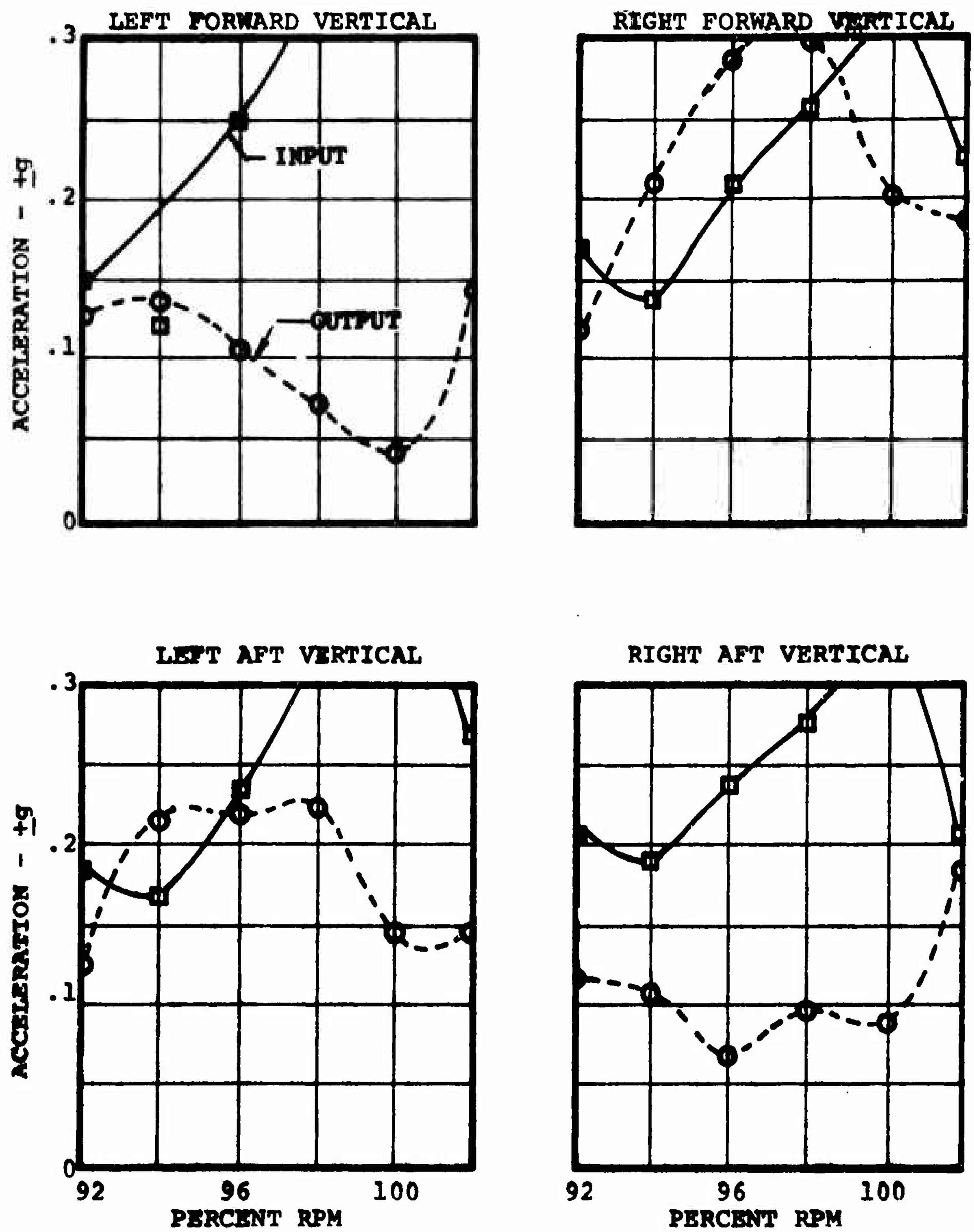


Figure 80. 30-Knot Four-Per-Rev Results of the 200-Pound With a Three-Inch CG Offset Unidirectional DAVI Platform on the Overload Gross Weight Helicopter.

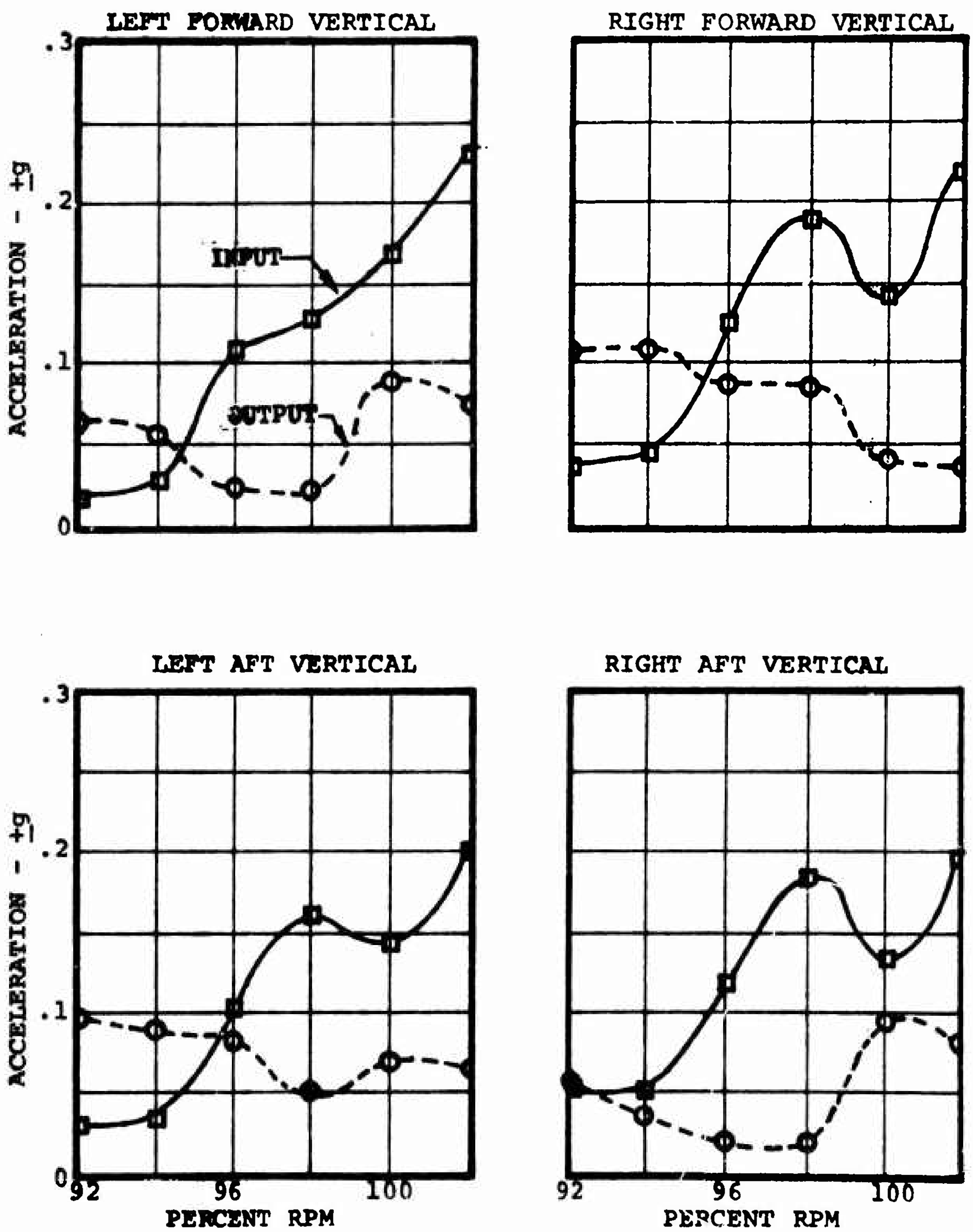


Figure 81. 105-Knot Four-Per-Rev Results of the 200-Pound With a Three-Inch CG Offset Unidirectional DAVI Platform on the Overload Gross Weight Helicopter.

COMPARISON OF THEORY AND TEST

Figures 82 through 85 show the flight test and theoretical results. These results are reported in the form of transmissibility in which the output accelerations on the platform were divided by the input accelerations to the platform.

The theoretical results were calculated using a twelve-degree-of-freedom rigid body analysis which is reported in Reference 3. In this analysis, effective hub forces and moments were used to reasonably reproduce the inputs to the isolated platform.

Reasonable agreement between theory and test was obtained.

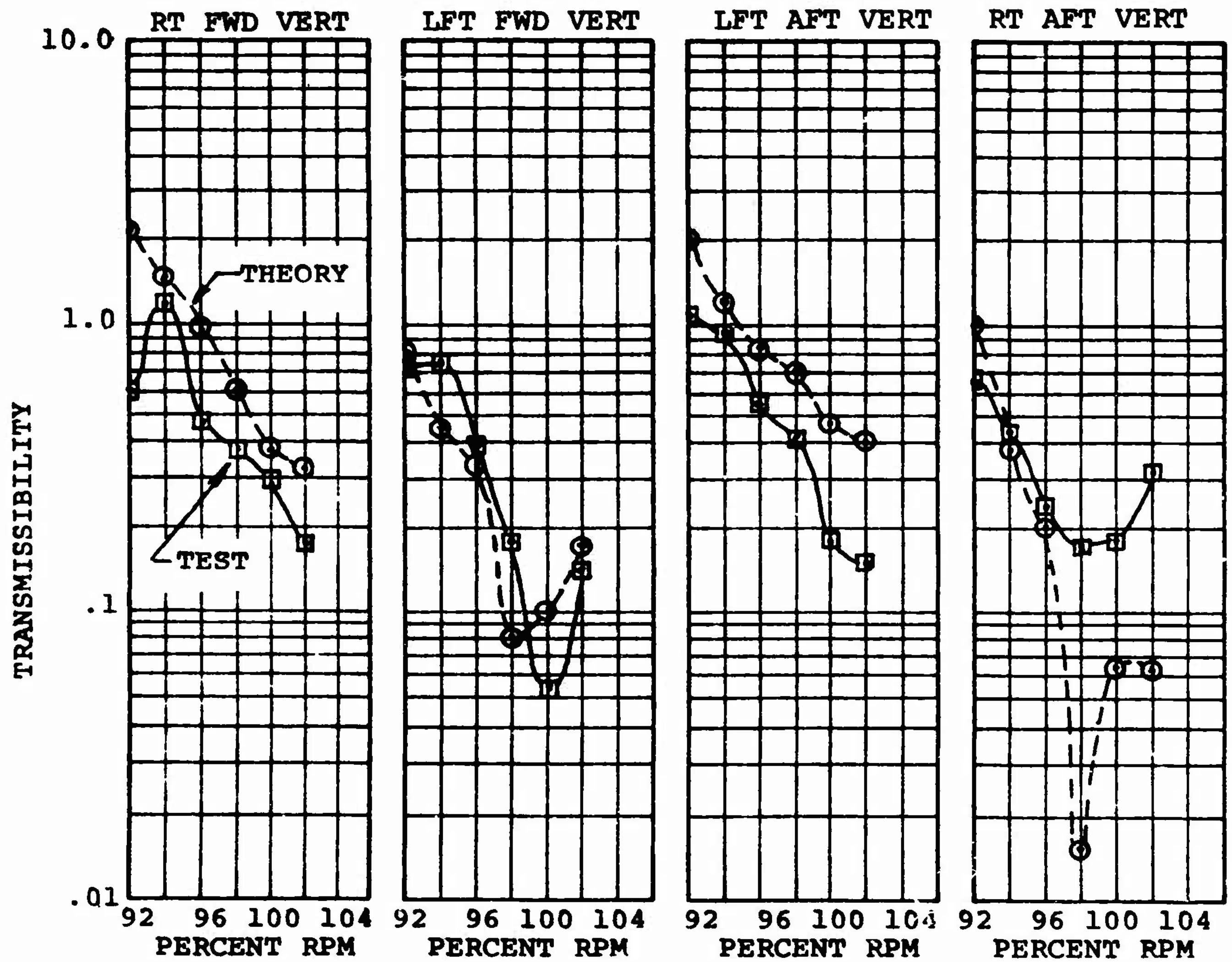


Figure 82. Transmissib'lity of the 50-Pound Unidirectional DAVI Platform at 30 Knots.

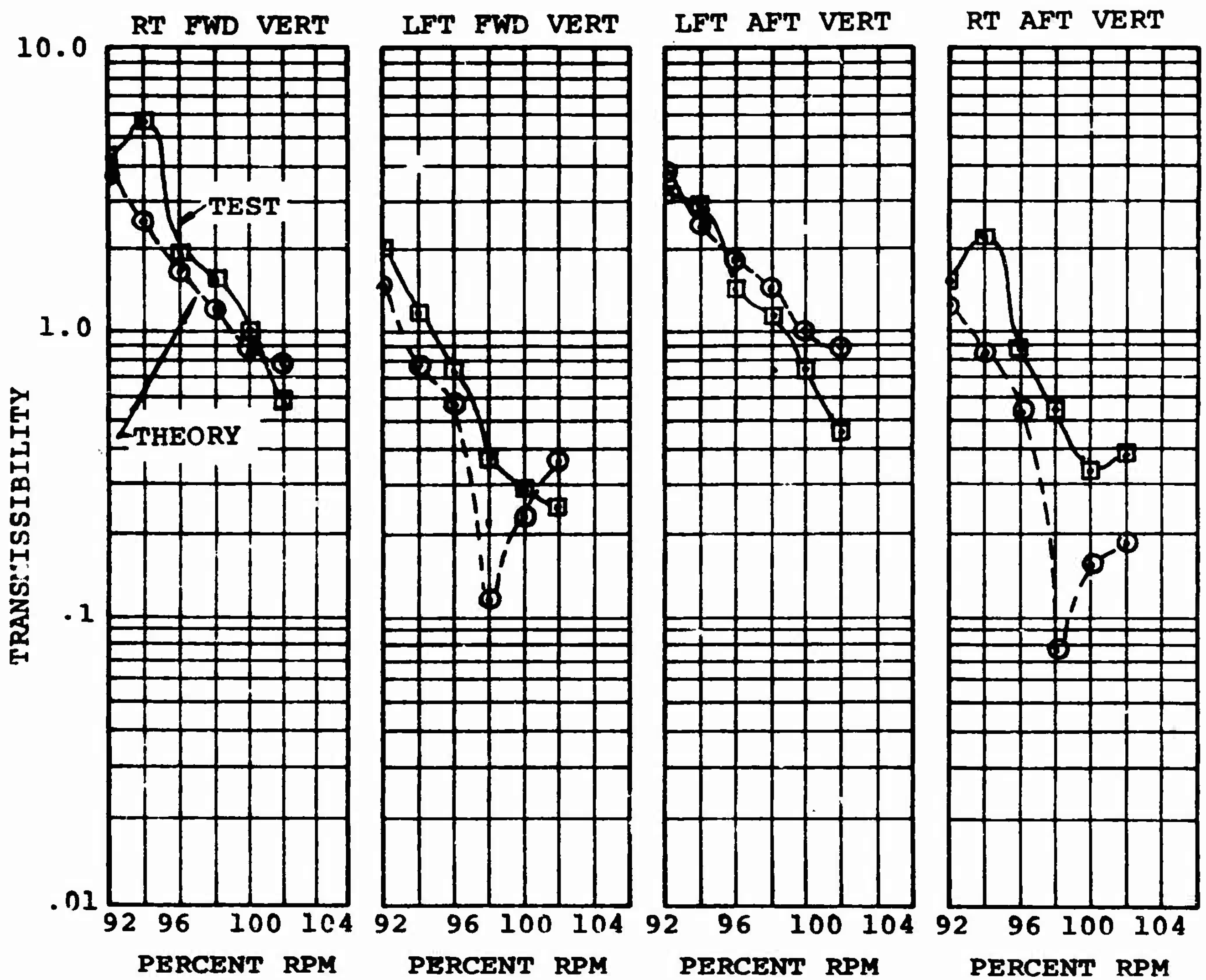


Figure 83. Transmissibility of the 150-Pound Unidirectional DAVI Platform at 30 Knots.

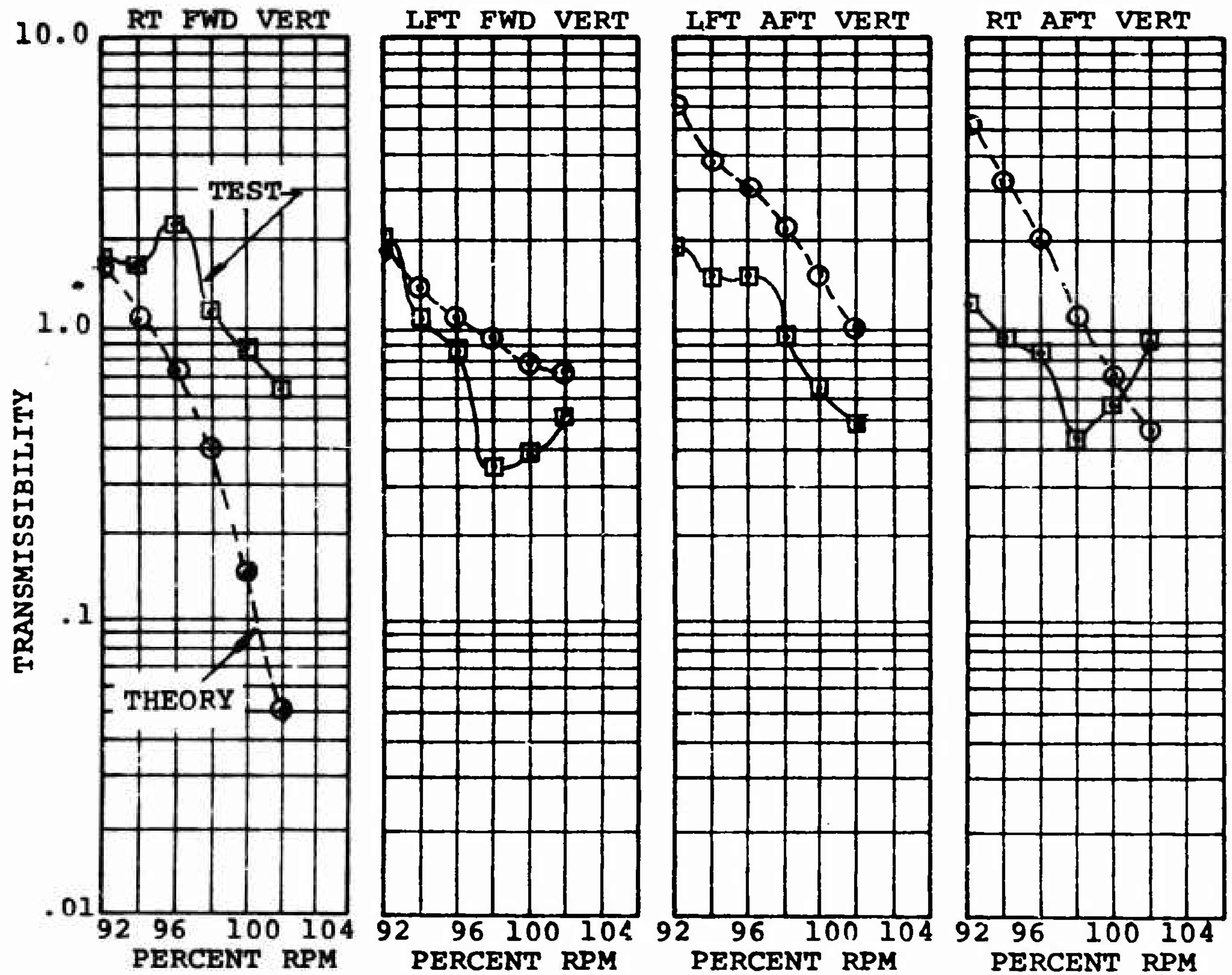


Figure 84. Transmissibility of the 200-Pound Unidirectional DAVI Platform at 30 Knots.

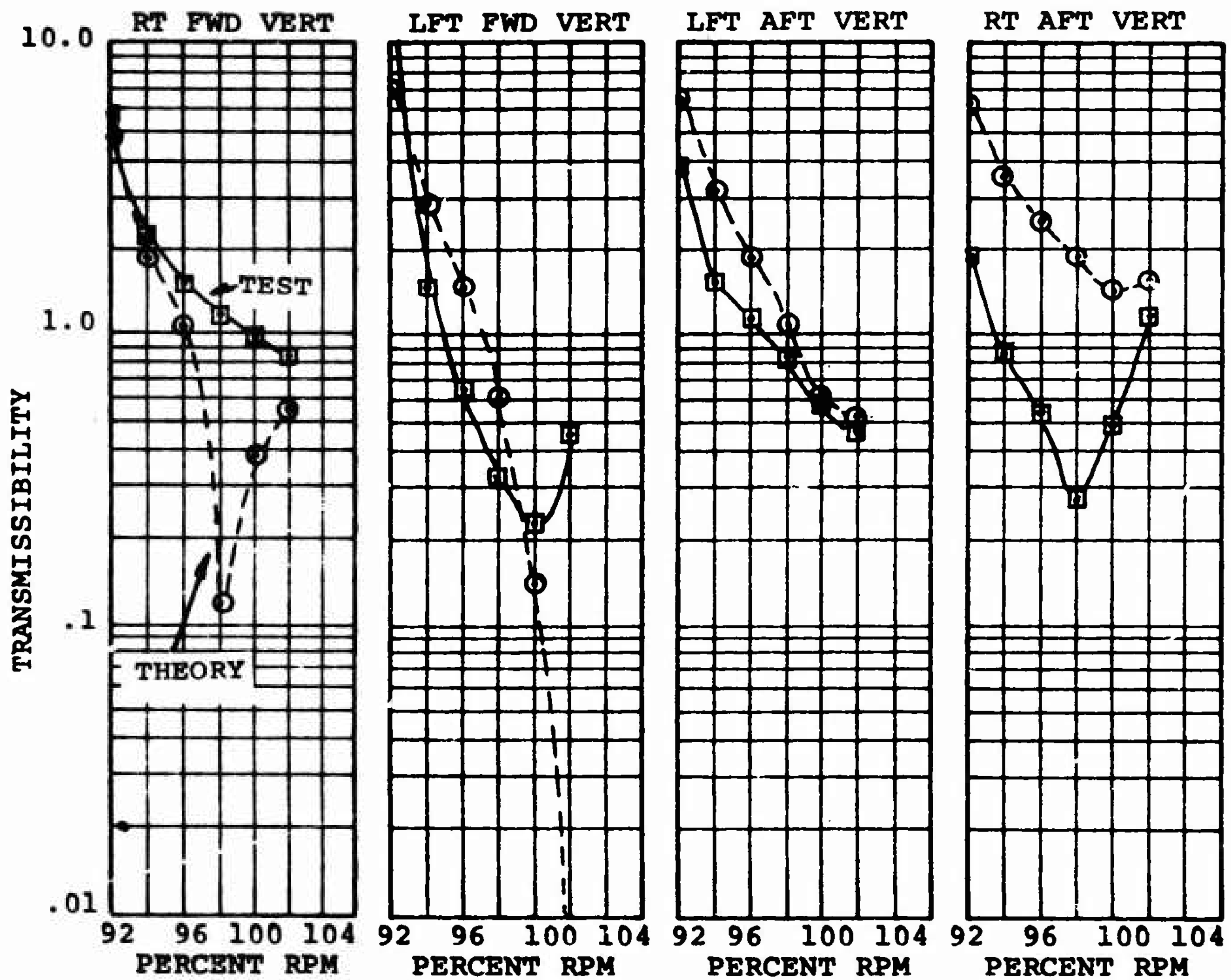


Figure 85. Transmissibility of the 200-Pound With a Three-Inch CG Offset Unidirectional DAVI Platform at 30 Knots.

TWO-DIMENSIONAL DAVI

TWO-DIMENSIONAL DAVI PLATFORM

Three two-dimensional DAVI pivot configurations were tested. The pivot configurations were rubber pivots, rod end bearing pivots, and Bendix flexural pivots. Figure 86 shows a schematic of the two-dimensional DAVI with rod end bearing pivots. In the two-dimensional DAVI, the inertia bar acts in the vertical and horizontal directions, therefore, the spring system is designed to have the same spring rate in the horizontal as in the vertical direction.

For each of the pivot configurations, four weight configurations of the two-dimensional DAVI platform were tested: a 50-pound, a 150-pound, a 200-pound, and a 200-pound with a three-inch center of gravity offset platform. Figure 87(a) shows the orientation of the two-dimensional DAVI platform as installed in the UH-2 helicopter. The two-dimensional DAVI inertia bar was oriented in the lateral direction and the pivots were offset from the spring in the lateral direction. This orientation of the two-dimensional DAVI inertia bar results in isolation in the vertical and longitudinal directions. This orientation of the two-dimensional DAVI inertia bar resulted from an analysis made on a twelve-degree-of-freedom rigid body program. This analysis, done for the 120-knot case, showed that the DAVI's should be oriented to give inertia bar action in the vertical and longitudinal directions. The system is essentially rigid in the lateral directions. All of the pivot and weight configurations of the two-dimensional DAVI platform were tested with this orientation.

Because of the poor results obtained on the two-dimensional DAVI platform, the two-dimensional DAVI was modified. This modification is shown in Figure 87(b); the two-dimensional DAVI inertia bar remained oriented in the lateral direction, but the pivot offset was in the longitudinal direction. In this configuration, only the Bendix flexural pivots were tested on the 50-pound platform, the 150-pound platform, and the 150-pound platform with redistributed weights. The redistributed weight of the 150-pound platform was accomplished by locating 50 pounds of the cylindrical weights equidistant (7.5 inches laterally) from the center line of the platform. This was done to change the inertia characteristics of the platform.

The location of the instrumentation used in this phase of the testing was the same as shown in Figure 13. The flight test conditions were the same as shown in Table V.

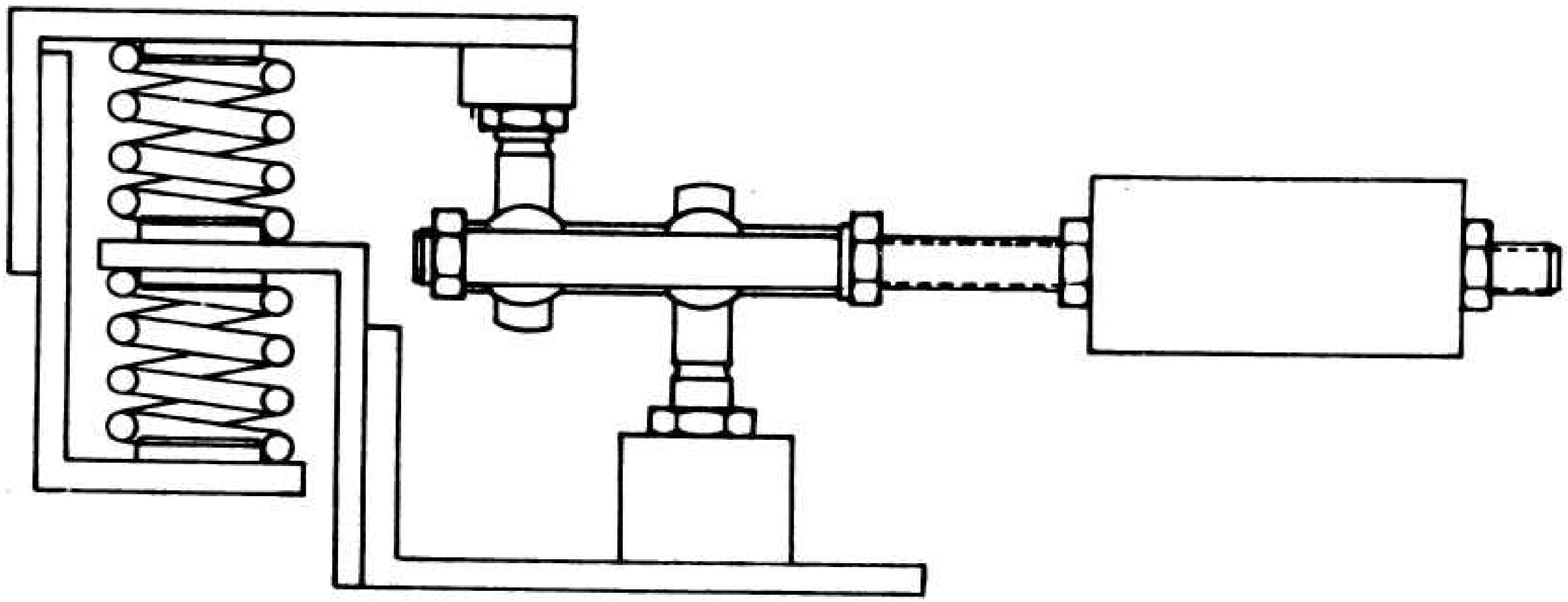
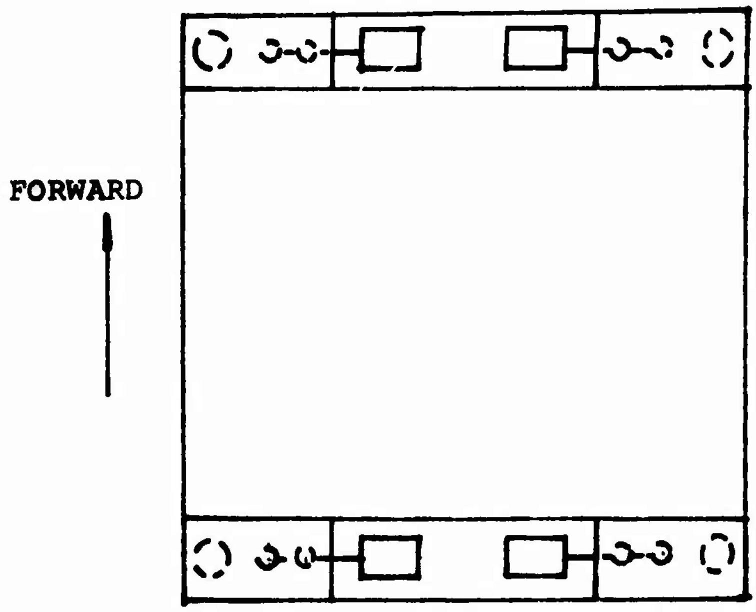
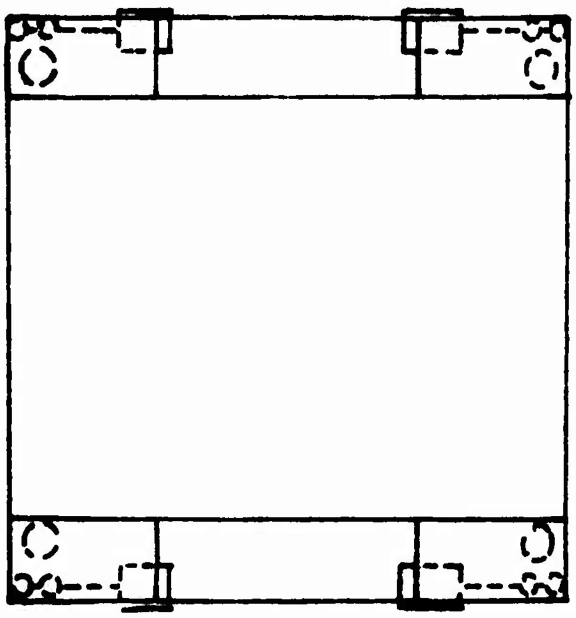


Figure 86. Schematic of the Two-Dimensional DAVI Model.



(a) LATERAL OFFSET OF PIVOTS



(b) LONGITUDINAL OFFSET OF PIVOTS

Figure 87. Schematic of the Two-Dimensional DAVI Platform.

FLIGHT TEST RESULTS

Figures 88 through 94 show typical oscillograph traces obtained in the level flight conditions on the two-dimensional DAVI utilizing the Bendix flexural pivots for all weight configurations of the platform for both the longitudinal and lateral offset of the pivots at 30 knots and at 100 percent rotor rpm. It is seen from these figures that very poor results were obtained. It is seen in Figure 88 that for the 50-pound platform, an apparent resonance condition existed, since excessive vibration levels were obtained on the platform. It is further seen in comparing Figures 88 and 89 that the direction of offset of the pivots affected the results obtained on the platform. For the lateral offset of the pivots, excessive rolling of the platform occurred resulting in high vibration levels, whereas for longitudinal offset, pitching of the platform occurred, but a reduction of vibration levels resulted.

Figures 95 through 97 show typical oscillograph traces obtained in the landing conditions for the 150-pound platform. These figures show the results obtained on the two-dimensional DAVI utilizing the Bendix flexural pivots. No high g level occurred for these transient conditions.

A 48-point Fourier analysis was done on the test data to obtain the magnitude of the predominant harmonics. Table VI gives the frequencies of the predominant harmonics.

Table XII gives the results of the Fourier analysis. The results obtained from the two-dimensional DAVI platform flight test program were very poor. In most cases for all weight configurations of the platform, an increase in the four-per-rev vibration level was obtained. In comparing the results obtained on the two-dimensional DAVI with lateral offset of the pivots to the results obtained on the two-dimensional DAVI with longitudinal offset, it is seen that the vibration characteristics were changed, but in both cases, the vibration levels were high. The 150-pound platform with the weights oriented laterally on the platform to increase the inertia of the platform had a much higher level of vibration.

Because of the poor results obtained on the two-dimensional platform, it was difficult to conclude which was the best pivot configuration. These poor results are attributed to

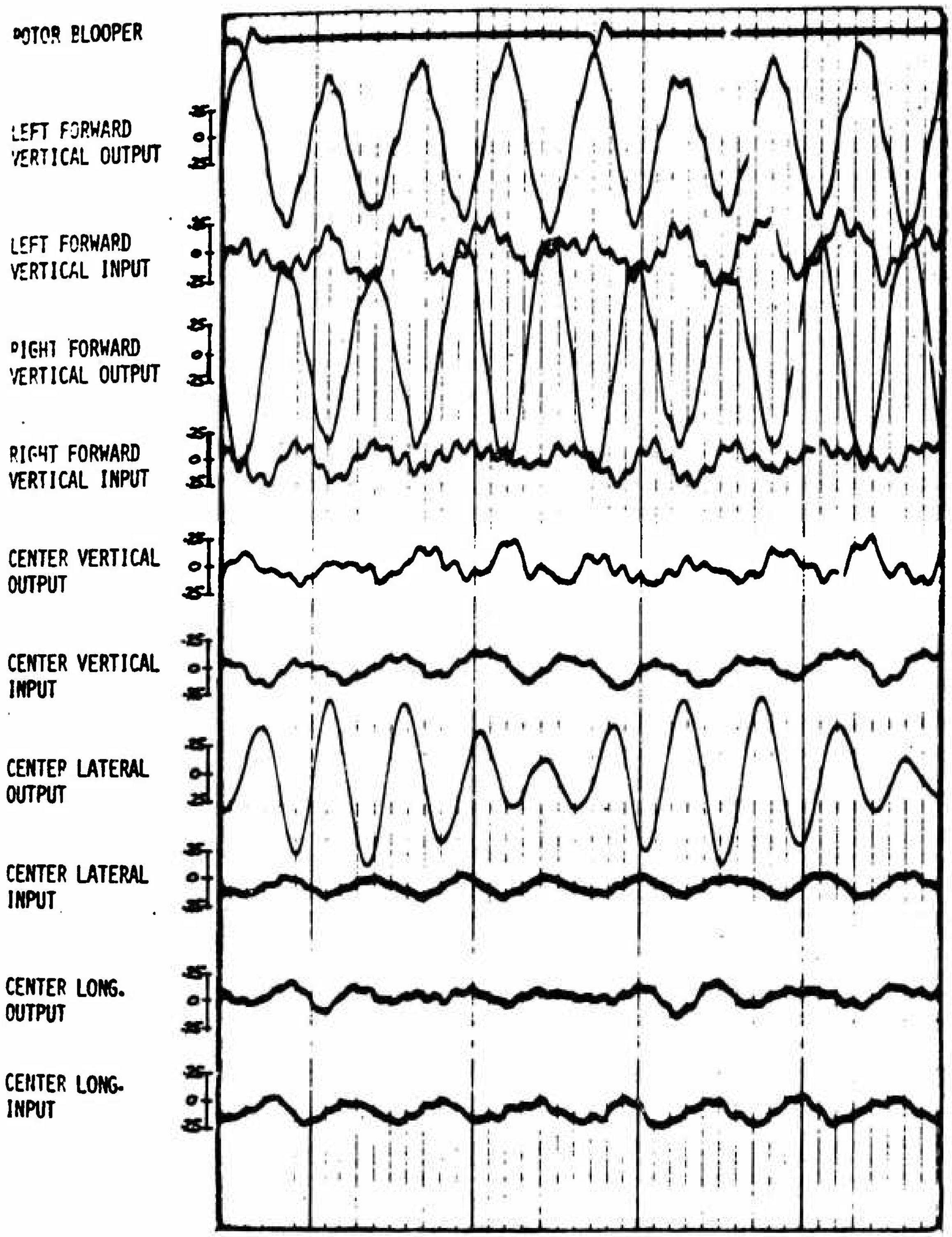


Figure 88. Oscillograph Traces of the Level Flight Conditions for the 50-Pound Two-Dimensional DAVI Platform With Laterally Offset Pivots.

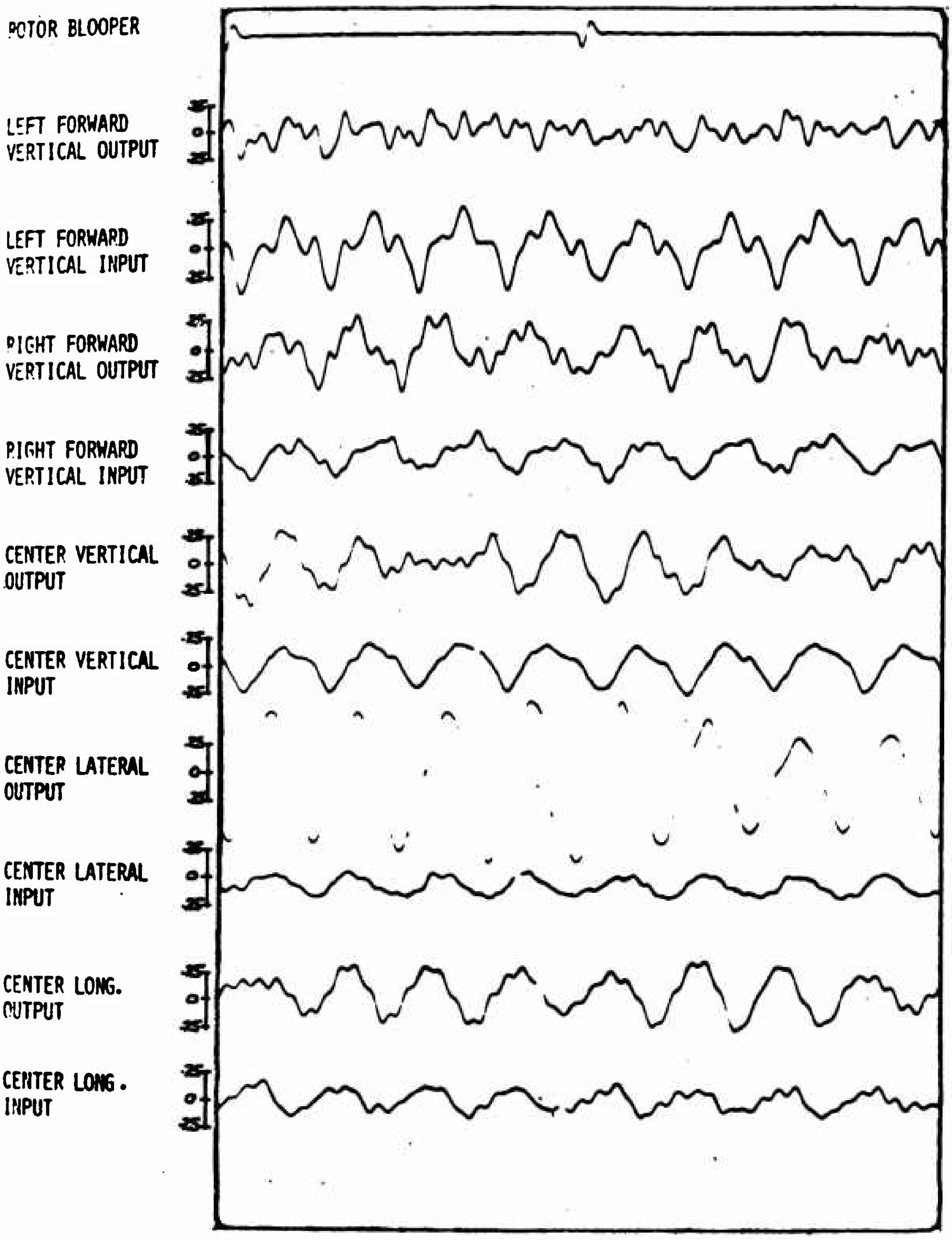


Figure 89. Oscillograph Traces of the Level Flight Conditions for the 50-Pound Two-Dimensional DAVI Platform With Longitudinally Offset Pivots.

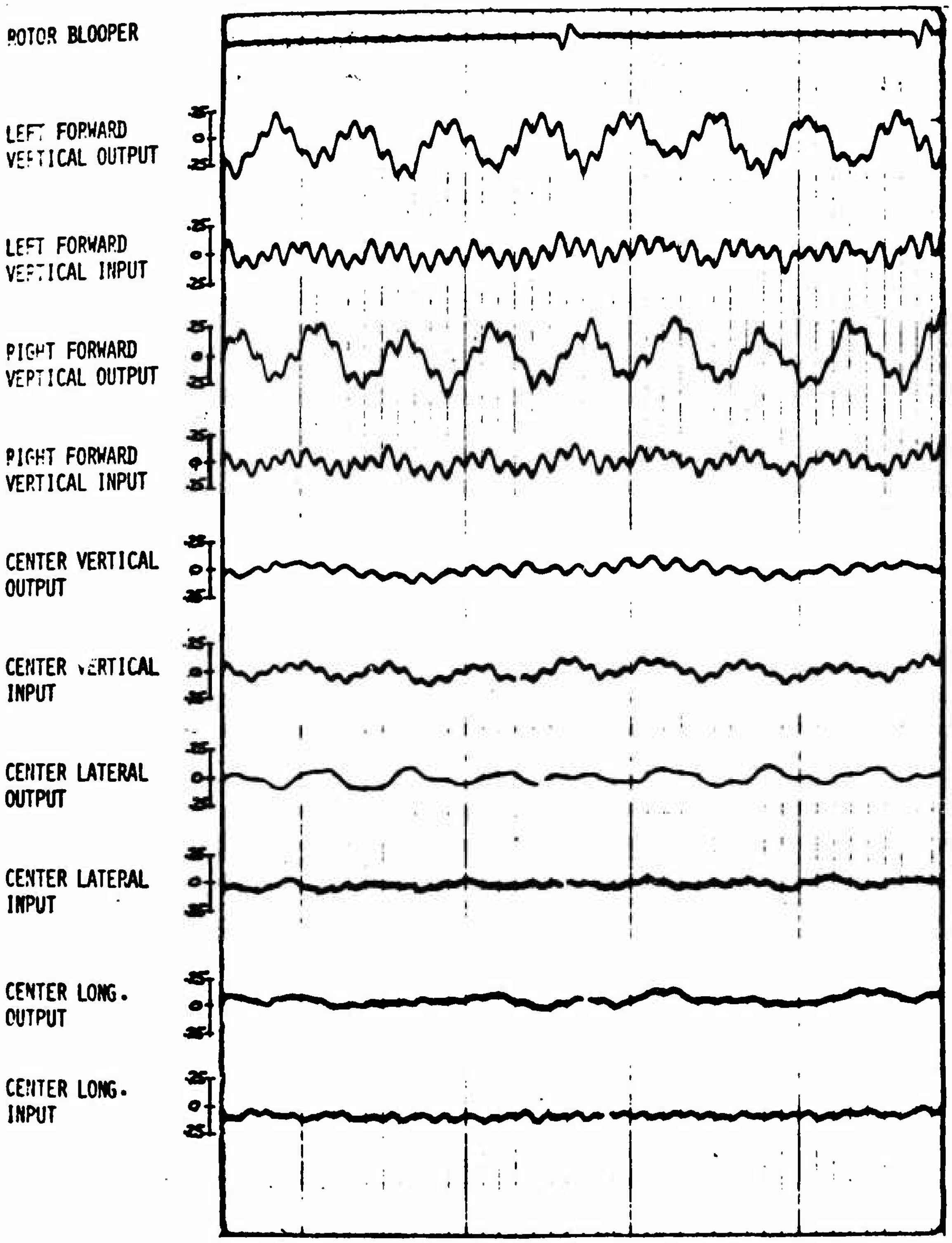


Figure 90. Oscillograph Traces of the Level Flight Conditions for the 150-Pound Two-Dimensional DAVI Platform With Laterally Offset Pivots.

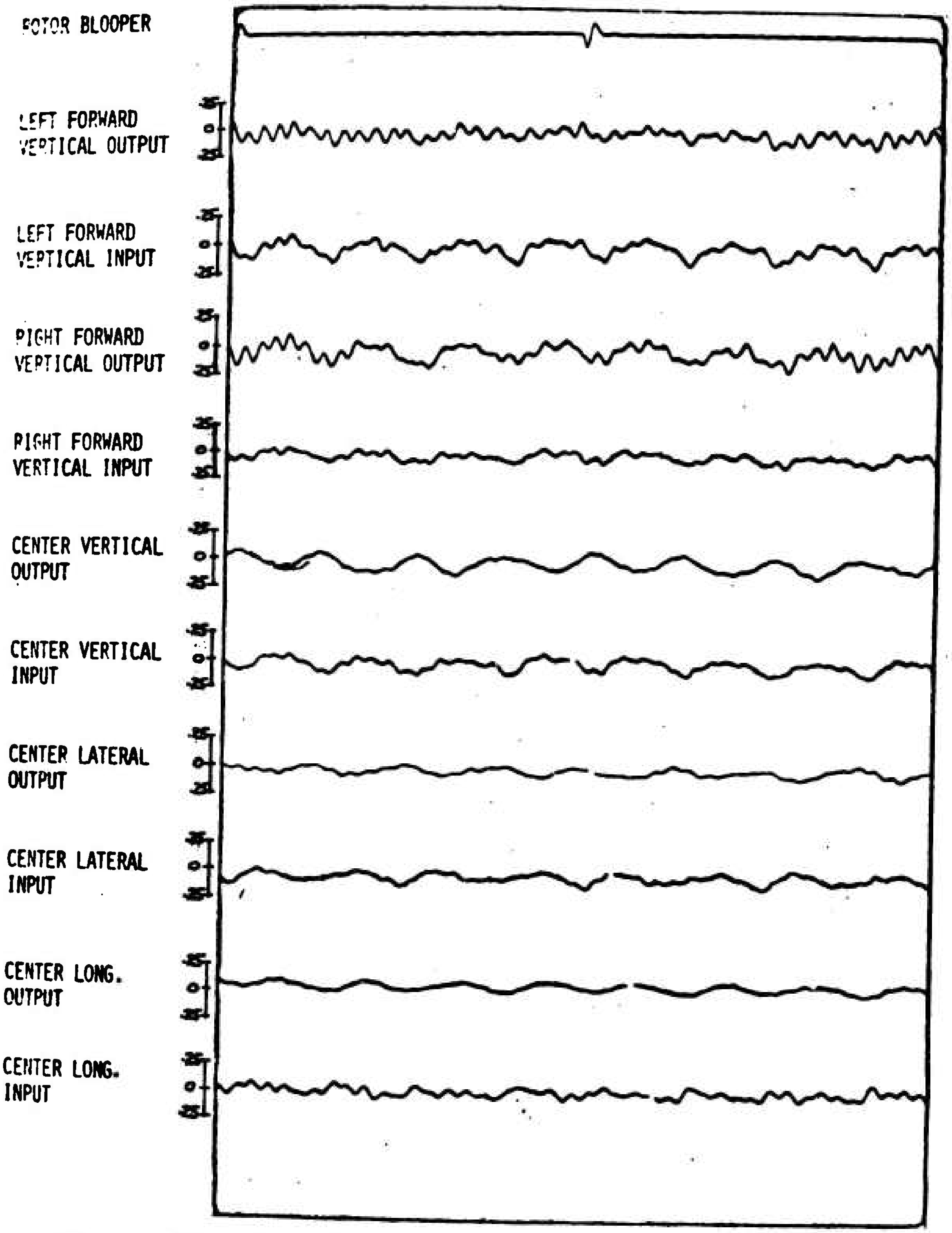


Figure 91. Oscillograph Traces of the Level Flight Conditions for the 150-Pound Two-Dimensional DAVI Platform With Longitudinally Offset Pivots.

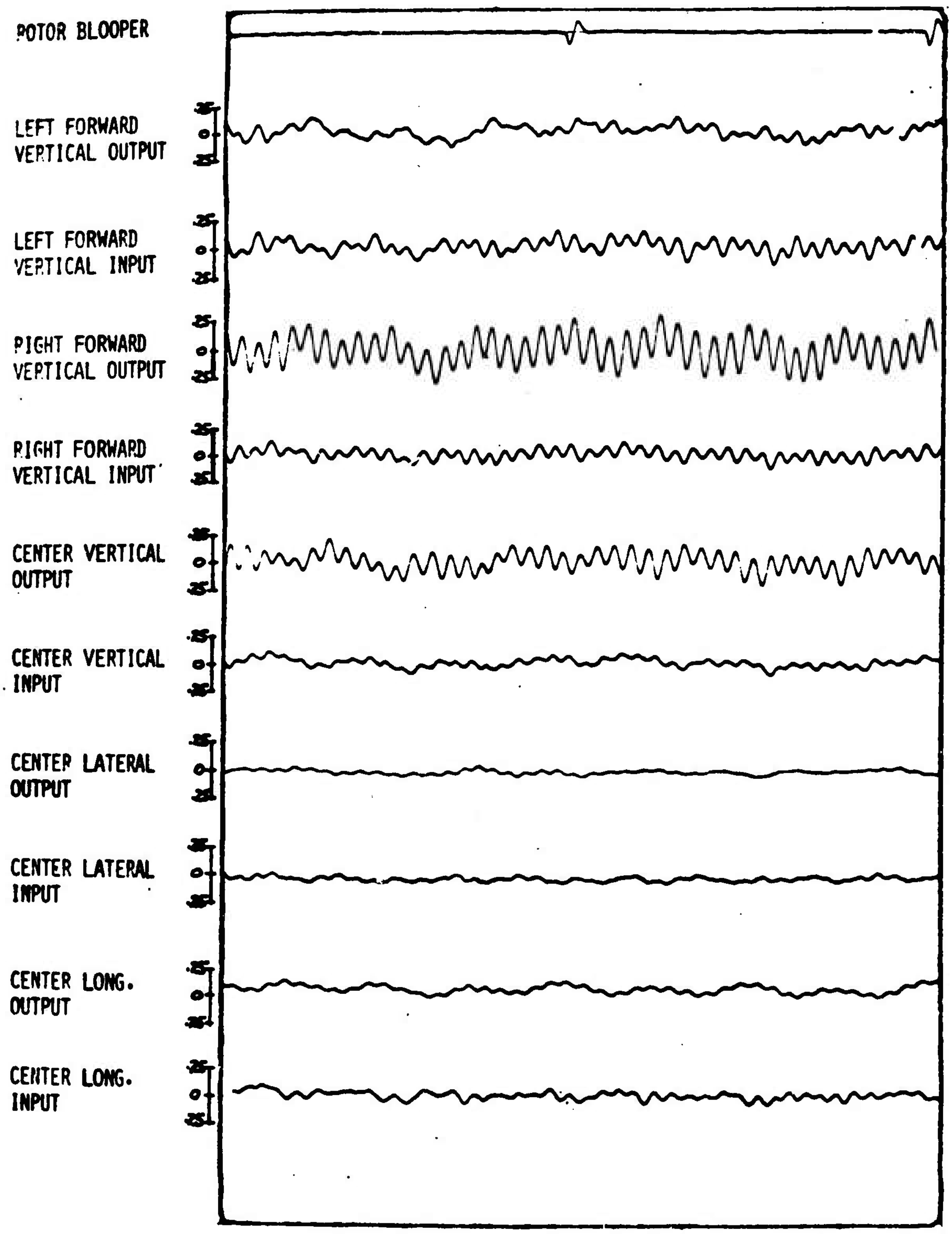


Figure 92. Oscillograph Traces of the Level Flight Conditions for the 150-Pound With Weights Offset Two-Dimensional DAVI Platform With Longitudinally Offset Pivots.

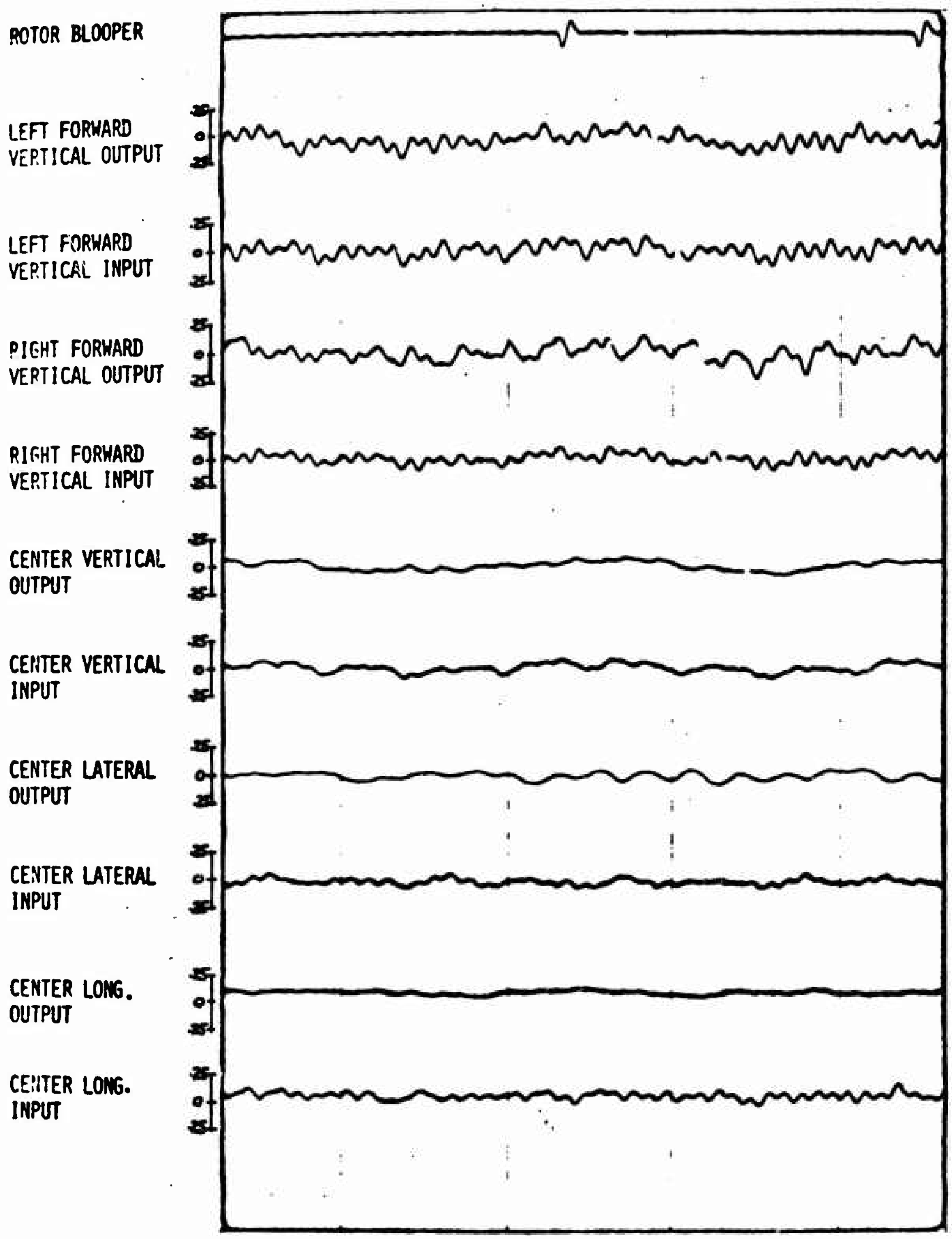


Figure 93. Oscillograph Traces of the Level Flight Conditions for the 200-Pound Two-Dimensional DAVI Platform With Laterally Offset Pivots.

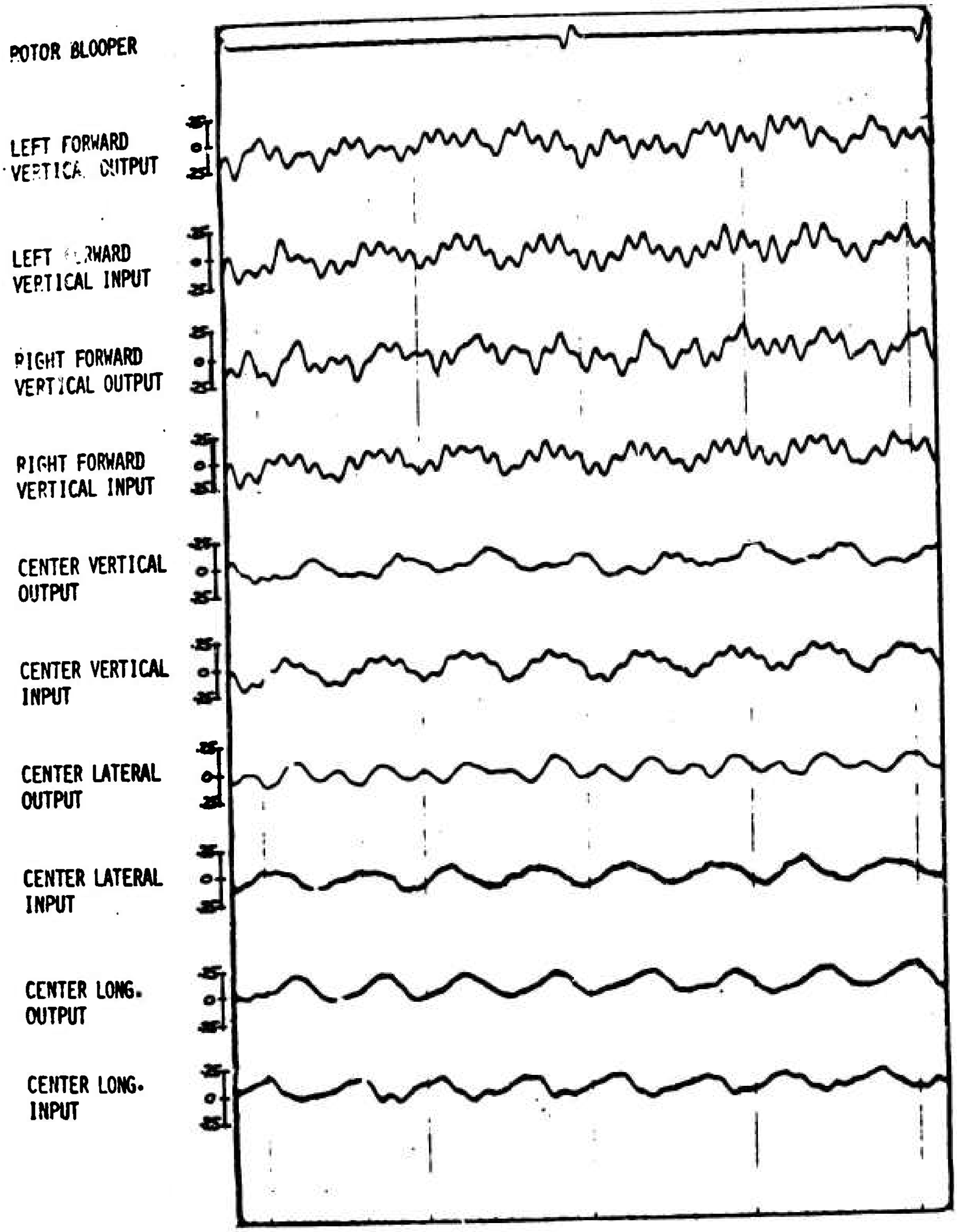


Figure 94. Oscillograph Traces of the Level Flight Conditions for the 200-Pound With Three-Inch Offset CG Two-Dimensional DAVI Platform With Laterally Offset Pivots.

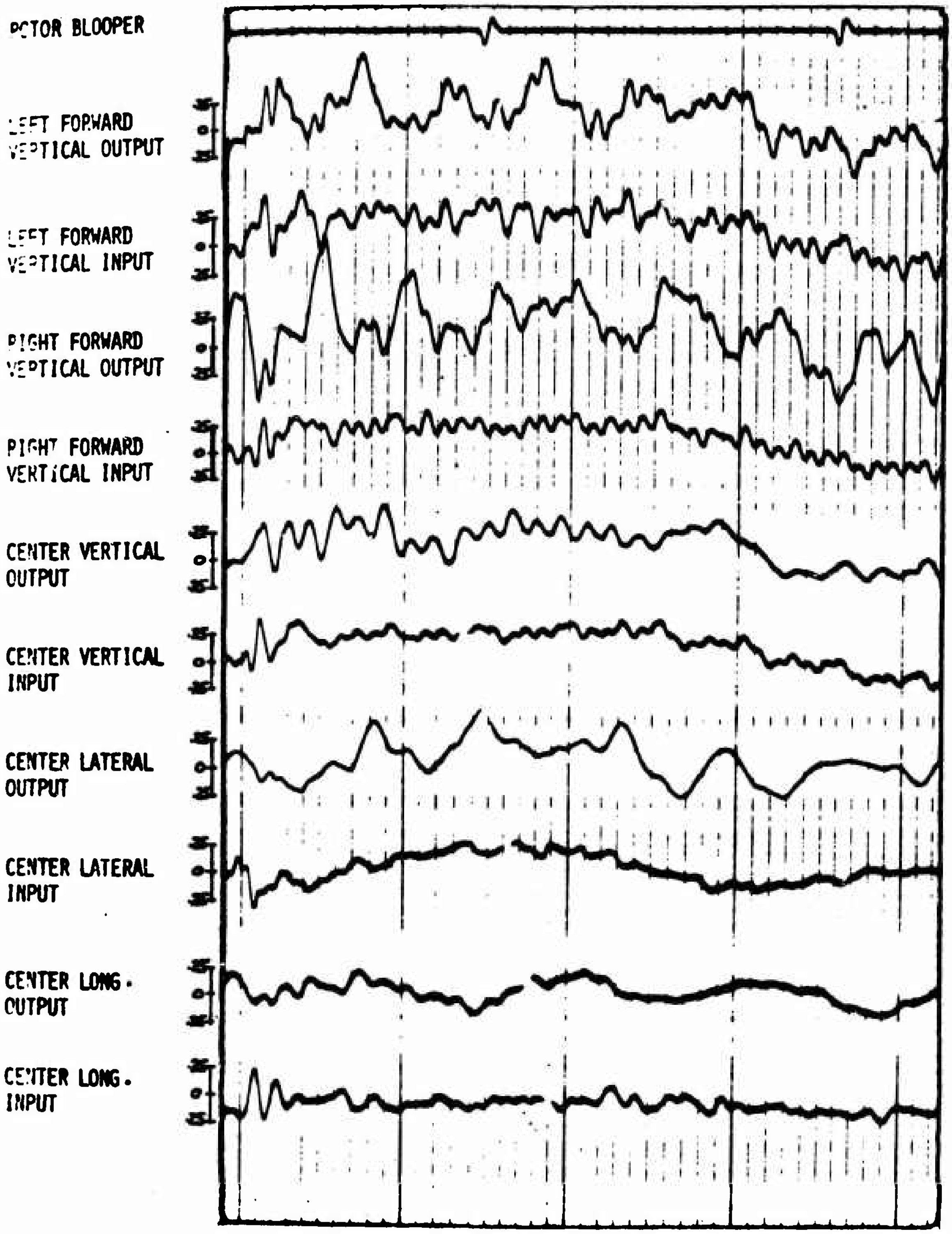


Figure 95. Oscillograph Traces of the Landing Conditions for the 150-Pound Two-Dimensional DAVI Platform With Laterally Offset Pivots.

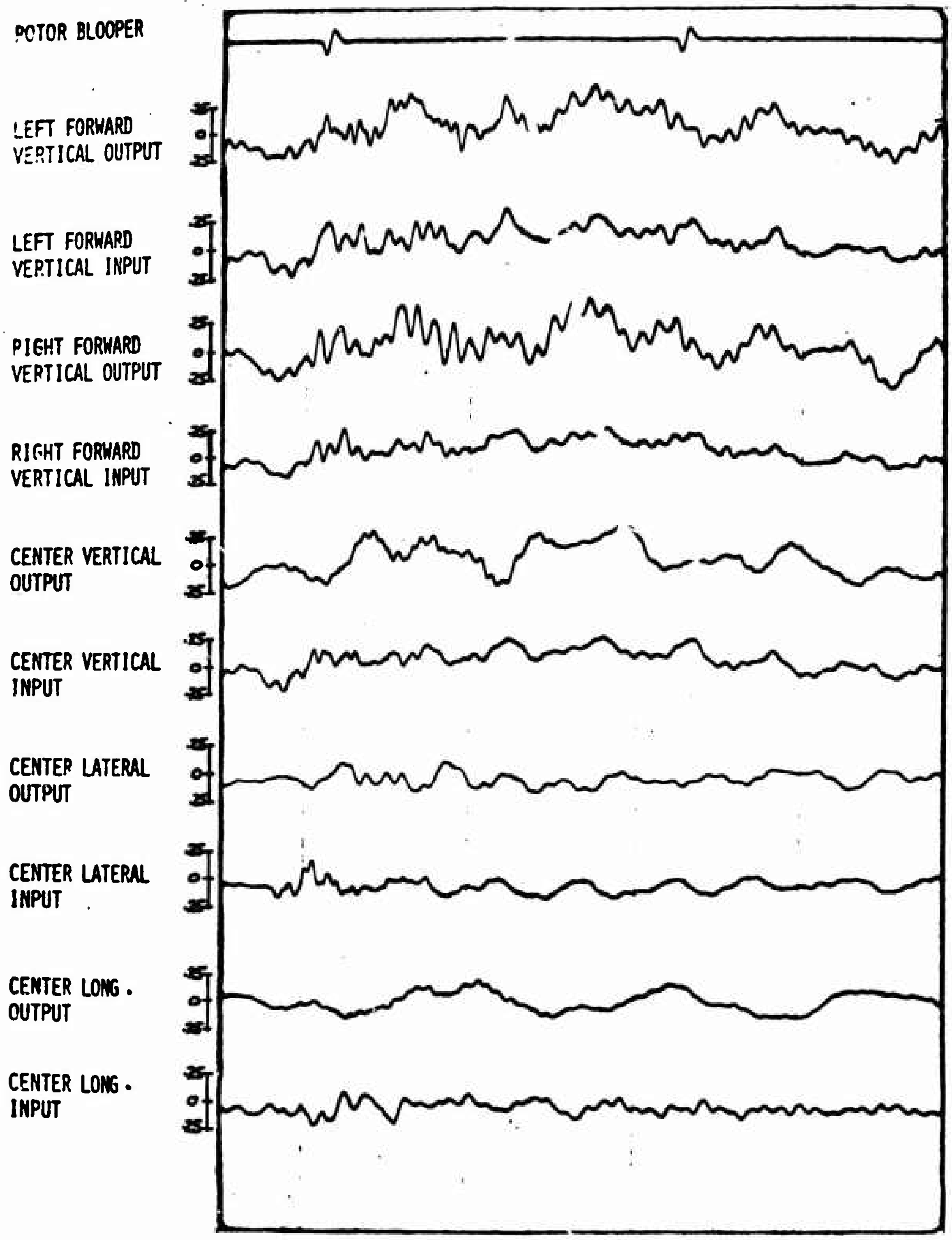


Figure 96. Oscillograph Traces of the Landing Conditions for the 150-Pound Two-Dimensional DAVI Platform With Longitudinally Offset Pivots.

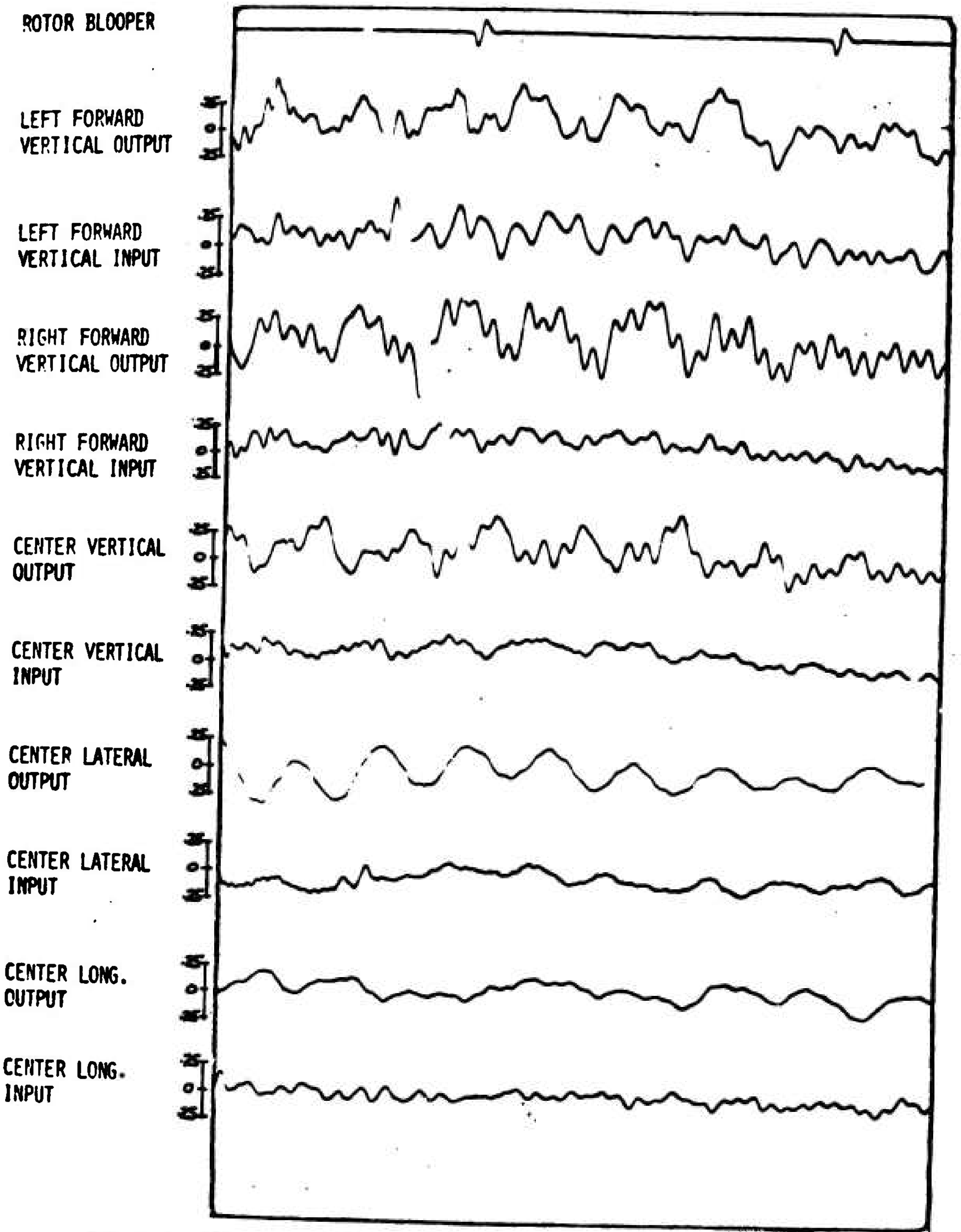


Figure 97. Oscillograph Traces of the Landing Conditions for the 150-Pound With Weights Offset Two-Dimensional DAVI Platform With Longitudinally Offset Pivots.

TABLE XII. PREDOMINANT VIBRATION LEVELS ON THE TWO-DIMENSIONAL DAVI PLATFORM

Pivot Configuration - Rod End Bearings

50-Pound Platform 30 Knots

Main Rotor Speed (% RPM)	Pickup Location	Main Rotor Harmonic Vibration Level (±g)					
		One/Rev		Four/Rev		Eight/Rev	
		Input	Output	Input	Output	Input	Output
92	Lft Fwd Vt	.023	.023	.078	.135	.024	.085
	Rt Fwd Vt	.020	.025	.103	.167	.028	.050
	Center Vt	.020	.024	.140	.137	.022	.036
	Center Long.	.001	.002	.137	.257	.003	.006
94	Lft Fwd Vt	.035	.039	.167	.029	.045	.047
	Rt Fwd Vt	.033	.035	.182	.243	.012	.069
	Center Vt	.034	.034	.228	.207	.033	.015
	Center Long.	.007	.005	.115	.202	.002	.013
96	Lft Fwd Vt	.036	.041	.240	.302	.049	.064
	Rt Fwd Vt	.038	.042	.188	.265	.022	.077
	Center Vt	.037	.046	.245	.197	.035	.020
	Center Long.	.002	.006	.127	.186	.009	.008
98	Lft Fwd Vt	.032	.032	.283	.386	.074	.028
	Rt Fwd Vt	.028	.033	.123	.239	.033	.053
	Center Vt	.031	.032	.197	.189	.065	.021
	Center Long.	.005	.002	.114	.107	.015	.029
100	Lft Fwd Vt	.034	.036	.600	.668	.049	.043
	Rt Fwd Vt	.031	.037	.023	.058	.071	.105
	Center Vt	.032	.039	.259	.068	.058	.047
	Center Long.	.007	.007	.120	.027	.005	.080
102	Lft Fwd Vt	.036	.042	.432	.477	.029	.100
	Rt Fwd Vt	.031	.035	.033	.043	.043	.065
	Center Vt	.037	.041	.160	.142	.051	.039
	Center Long.	.002	.002	.120	.059	.028	.078

TABLE XII - Continued

Pivot Configuration - Rod End Bearings

50-Pound Platform | 120 Knots

Main Rotor Speed (% RPM)	Pickup Location	Main Rotor Harmonic Vibration Level (±g) One/Rev Input	One/Rev Output	Four/Rev Input	Four/Rev Output	Eight/Rev Input	Eight/Rev Output
92	Lft Fwd Vt	.004	.005	.043	.026	.023	.035
	Rt Fwd Vt	.008	.013	.021	.036	.029	.019
	Center Vt	.007	.006	.027	.019	.019	.027
	Center Long.	.011	.012	.094	.163	.042	.034
94	Lft Fwd Vt	.030	.036	.056	.078	.014	.052
	Rt Fwd Vt	.028	.037	.062	.130	.051	.079
	Center Vt	.031	.033	.069	.142	.038	.013
	Center Long.	.012	.012	.106	.222	.040	.047
96	Lft Fwd Vt	.017	.019	.087	.129	.022	.053
	Rt Fwd Vt	.016	.017	.094	.200	.043	.075
	Center Vt	.017	.020	.106	.127	.036	.002
	Center Long.	.011	.012	.133	.252	.038	.035
98	Lft Fwd Vt	.012	.013	.100	.140	.029	.078
	Rt Fwd Vt	.013	.013	.093	.209	.050	.052
	Center Vt	.016	.015	.111	.179	.035	.013
	Center Long.	.011	.012	.151	.234	.034	.039
102	Lft Fwd Vt	.025	.023	.117	.159	.043	.050
	Rt Fwd Vt	.029	.030	.070	.176	.021	.034
	Center Vt	.024	.032	.094	.167	.040	.012
	Center Long.	.017	.018	.156	.194	.017	.024

TABLE XII - Continued							
Pivot Configuration - Rod End Bearings							
150-Pound Platform 30 Knots							
Main Rotor Speed (% RPM)	Pickup Location	Main Rotor Harmonic Vibration Level(±g)					
		One/Rev		Four/Rev		Eight/Rev	
		Input	Output	Input	Output	Input	Output
92	Lft Fwd Vt	.028	.028	.117	.162	.043	.044
	Rt Fwd Vt	.023	.027	.118	.146	.004	.030
	Center Vt	.026	.032	.180	.075	.023	.011
	Center Long.	.004	.004	.166	.057	.007	.010
94	Lft Fwd Vt	.028	.025	.155	.194	.048	.062
	Rt Fwd Vt	.023	.029	.141	.152	.013	.022
	Center Vt	.025	.037	.187	.104	.032	.009
	Center Long.	.001	.003	.117	.033	.003	.008
96	Lft Fwd Vt	.025	.026	.290	.398	.069	.099
	Rt Fwd Vt	.028	.033	.229	.317	.037	.020
	Center Vt	.031	.040	.298	.191	.051	.026
	Center Long.	.005	.008	.105	.066	.008	.006
98	Lft Fwd Vt	.026	.023	.179	.235	.016	.069
	Rt Fwd Vt	.023	.027	.144	.158	.033	.015
	Center Vt	.024	.035	.170	.118	.031	.020
	Center Long.	.003	.005	.066	.031	.015	.011
100	Lft Fwd Vt	.057	.063	.217	.315	.026	.106
	Rt Fwd Vt	.050	.061	.166	.221	.058	.072
	Center Vt	.055	.073	.182	.149	.071	.005
	Center Long.	.011	.012	.121	.036	.021	.010
102	Lft Fwd Vt	.048	.055	.192	.276	.041	.087
	Rt Fwd Vt	.039	.057	.129	.156	.027	.020
	Center Vt	.047	.066	.146	.132	.036	.024
	Center Long.	.009	.007	.122	.033	.023	.007

TABLE XII - Continued							
Pivot Configuration - Rod End Bearings							
150-Pound Platform 120 Knots							
Main Rotor Speed (% RPM)	Pickup Location	Main Rotor Harmonic Vibration Level(±g)					
		One/Rev		Four/Rev		Eight/Rev	
		Input	Output	Input	Output	Input	Output
92	Lft Fwd Vt	.015	.015	.026	.050	.006	.021
	Rt Fwd Vt	.015	.016	.034	.028	.036	.016
	Center Vt	.015	.014	.036	.022	.026	.006
	Center Long.	.011	.017	.100	.037	.054	.011
94	Lft Fwd Vt	.011	.009	.057	.062	.021	.033
	Rt Fwd Vt	.012	.010	.051	.072	.043	.023
	Center Vt	.006	.006	.074	.017	.039	.001
	Center Long.	.013	.016	.114	.044	.032	.009
96	Lft Fwd Vt	.016	.016	.107	.109	.030	.037
	Rt Fwd Vt	.016	.019	.097	.132	.025	.012
	Center Vt	.015	.015	.134	.055	.020	.007
	Center Long.	.008	.009	.140	.067	.012	.004
98	Lft Fwd Vt	.015	.015	.116	.122	.026	.036
	Rt Fwd Vt	.021	.027	.112	.130	.018	.045
	Center Vt	.017	.019	.141	.056	.015	.001
	Center Long.	.012	.019	.140	.067	.015	.004
100	Lft Fwd Vt	.020	.021	.098	.098	.029	.013
	Rt Fwd Vt	.014	.014	.102	.140	.008	.029
	Center Vt	.014	.020	.109	.081	.013	.005
	Center Long.	.016	.023	.155	.082	.009	.008
102	Lft Fwd Vt	.006	.006	.091	.086	.028	.025
	Rt Fwd Vt	.006	.008	.081	.102	.001	.068
	Center Vt	.007	.005	.095	.056	.017	.016
	Center Long.	.015	.023	.147	.062	.026	.008

TABLE XII - Continued

Pivot Configuration - Rod End Bearings

200-Pound Platform 30 Knots

Main Rotor Speed (% RPM)	Pickup Location	Main Rotor Harmonic Vibration Level (±g) One/Rev Input	One/Rev Output	Four/Rev Input	Four/Rev Output	Eight/Rev Input	Eight/Rev Output
92	Lft Fwd Vt	.048	.051	.167	.201	.040	.108
	Rt Fwd Vt	.040	.049	.165	.168	.024	.079
	Center Vt	.046	.059	.244	.055	.040	.007
	Center Long.	.006	.009	.173	.026	.011	.012
94	Lft Fwd Vt	.005	.005	.181	.223	.023	.158
	Rt Fwd Vt	.001	.009	.172	.204	.031	.081
	Center Vt	.006	.016	.225	.089	.028	.008
	Center Long.	.004	.003	.114	.034	.005	.016
96	Lft Fwd Vt	.024	.033	.273	.257	.048	.126
	Rt Fwd Vt	.022	.035	.265	.249	.092	.131
	Center Vt	.022	.038	.318	.107	.086	.019
	Center Long.	.003	.007	.108	.057	.022	.013
98	Lft Fwd Vt	.035	.041	.199	.214	.042	.134
	Rt Fwd Vt	.048	.028	.090	.179	.004	.036
	Center Vt	.032	.048	.204	.090	.045	.004
	Center Long.	.008	.014	.122	.057	.005	.015
100	Lft Fwd Vt	.025	.039	.254	.238	.060	.160
	Rt Fwd Vt	.027	.033	.224	.218	.072	.152
	Center Vt	.028	.041	.251	.111	.071	.010
	Center Long.	.006	.006	.119	.069	.013	.009
102	Lft Fwd Vt	.026	.032	.215	.218	.032	.182
	Rt Fwd Vt	.022	.032	.181	.172	.053	.100
	Center Vt	.023	.036	.196	.097	.047	.011
	Center Long.	.005	.009	.110	.067	.033	.010

TABLE XII - Continued							
Pivot Configuration - Rod End Bearings							
200-Pound Platform 120 Knots							
Main Rotor Speed (% RPM)	Pickup Location	Main Rotor Harmonic Vibration Level($\pm$g)					
		One/Rev		Four/Rev		Eight/Rev	
		Input	Output	Input	Output	Input	Output
92	Lft Fwd Vt	.008	.011	.048	.011	.007	.011
	Rt Fwd Vt	.009	.011	.047	.021	.037	.021
	Center Vt	.005	.005	.059	.022	.026	.008
	Center Long.	.002	.010	.116	.028	.046	.008
94	Lft Fwd Vt	.022	.027	.045	.021	.030	.026
	Rt Fwd Vt	.020	.031	.044	.029	.044	.006
	Center Vt	.018	.026	.061	.023	.036	.003
	Center Long.	.008	.013	.099	.020	.042	.009
96	Lft Fwd Vt	.022	.027	.096	.036	.042	.035
	Rt Fwd Vt	.024	.030	.087	.080	.034	.037
	Center Vt	.026	.030	.124	.021	.040	.016
	Center Long.	.010	.016	.128	.032	.045	.014
98	Lft Fwd Vt	.019	.022	.096	.045	.028	.058
	Rt Fwd Vt	.019	.028	.091	.056	.020	.023
	Center Vt	.025	.029	.123	.020	.021	.013
	Center Long.	.013	.034	.142	.020	.019	.010
100	Lft Fwd Vt	.015	.016	.095	.021	.019	.038
	Rt Fwd Vt	.015	.015	.087	.052	.008	.062
	Center Vt	.016	.017	.110	.020	.019	.008
	Center Long.	.006	.012	.137	.024	.022	.009
102	Lft Fwd Vt	.008	.011	.084	.047	.031	.024
	Rt Fwd Vt	.015	.021	.083	.030	.004	.026
	Center Vt	.018	.018	.102	.035	.019	.005
	Center Long.	.012	.019	.154	.040	.010	.003

TABLE XII - Continued							
Pivot Configuration - Rod End Bearings							
200-Pound Platform With 3-Inch Offset CG 30 Knots							
Main Rotor Speed (% RPM)	Pickup Location	Main Rotor Harmonic Vibration Level (±g)					
		One/Rev		Four/Rev		Eight/Rev	
		Input	Output	Input	Output	Input	Output
92	Lft Fwd Vt	.031	.033	.115	.018	.042	.020
	Rt Fwd Vt	.025	.026	.154	.253	.006	.023
	Center Vt	.032	.045	.201	.087	.029	.019
	Center Long.	.007	.009	.166	.031	.007	.011
94	Lft Fwd Vt	.033	.041	.233	.102	.051	.046
	Rt Fwd Vt	.029	.039	.273	.400	.050	.096
	Center Vt	.025	.051	.323	.051	.068	.010
	Center Long.	.007	.019	.138	.023	.014	.020
96	Lft Fwd Vt	.037	.042	.338	.124	.033	.050
	Rt Fwd Vt	.037	.050	.250	.410	.039	.055
	Center Vt	.041	.055	.280	.046	.053	.003
	Center Long.	.006	.010	.124	.044	.012	.020
98	Lft Fwd Vt	.025	.030	.214	.128	.051	.050
	Rt Fwd Vt	.027	.033	.235	.411	.051	.050
	Center Vt	.026	.040	.248	.038	.055	.008
	Center Long.	.004	.007	.114	.056	.002	.011
100	Lft Fwd Vt	.028	.025	.227	.144	.103	.058
	Rt Fwd Vt	.022	.028	.254	.387	.115	.076
	Center Vt	.026	.035	.248	.031	.112	.019
	Center Long.	.003	.004	.088	.078	.029	.002
102	Lft Fwd Vt	.033	.037	.020	.135	.082	.059
	Rt Fwd Vt	.026	.033	.199	.337	.081	.066
	Center Vt	.042	.041	.195	.033	.080	.016
	Center Long.	.004	.011	.024	.077	.009	.015

TABLE XII - Continued

Pivot Configuration - Rod End Bearings

200-Pound Platform With 3-Inch CG Offset 120 Knots

Main Rotor Speed (% RPM)	Pickup Location	Main Rotor Harmonic Vibration Level ($\pm g$) One/Rev Input	One/Rev Output	Four/Rev Input	Four/Rev Output	Eight/Rev Input	Eight/Rev Output
92	Lft Fwd Vt	.021	.022	.042	.022	.011	.015
	Rt Fwd Vt	.020	.024	.062	.077	.039	.020
	Center Vt	.024	.023	.059	.054	.024	.009
	Center Long.	.012	.017	.114	.023	.046	.011
94	Lft Fwd Vt	.029	.035	.040	.016	.034	.017
	Rt Fwd Vt	.029	.039	.055	.088	.041	.019
	Center Vt	.029	.042	.066	.046	.039	.016
	Center Long.	.016	.019	.089	.022	.039	.013
96	Lft Fwd Vt	.022	.025	.111	.045	.037	.017
	Rt Fwd Vt	.027	.029	.112	.216	.032	.018
	Center Vt	.026	.034	.140	.084	.041	.002
	Center Long.	.013	.022	.128	.043	.033	.017
98	Lft Fwd Vt	.016	.021	.109	.065	.042	.033
	Rt Fwd Vt	.014	.022	.115	.248	.015	.004
	Center Vt	.019	.025	.141	.080	.029	.004
	Center Long.	.012	.028	.130	.032	.039	.018
100	Lft Fwd Vt	.013	.015	.103	.060	.023	.022
	Rt Fwd Vt	.016	.020	.099	.228	.009	.069
	Center Vt	.015	.019	.126	.081	.020	.004
	Center Long.	.012	.020	.136	.037	.027	.004
102	Lft Fwd Vt	.013	.018	.099	.051	.034	.020
	Rt Fwd Vt	.017	.026	.099	.194	.019	.034
	Center Vt	.016	.021	.123	.087	.034	.011
	Center Long.	.015	.025	.150	.027	.024	.006

TABLE XII - Continued

Pivot Configuration - Rubber

50-Pound Platform   30 Knots

Main Rotor Speed (% RPM)	Pickup Location	Main Rotor Harmonic Vibration Level (±g)					
		One/Rev		Four/Rev		Eight/Rev	
		Input	Output	Input	Output	Input	Output
92	Lft Fwd Vt	.019	.021	.136	.077	.037	.024
	Rt Fwd Vt	.016	.023	.194	.026	.022	.013
	Center Vt	.024	.021	.246	.103	.031	.022
	Center Long.	.007	.004	.159	.076	.002	.014
94	Lft Fwd Vt	.029	.032	.220	.066	.053	.025
	Rt Fwd Vt	.026	.032	.251	.041	.042	.021
	Center Vt	.028	.030	.298	.109	.057	.048
	Center Long.	.008	.007	.127	.050	.004	.018
96	Lft Fwd Vt	.021	.021	.199	.044	.019	.005
	Rt Fwd Vt	.019	.019	.186	.055	.018	.025
	Center Vt	.015	.019	.229	.068	.028	.014
	Center Long.	.015	.010	.107	.030	.006	.026
98	Lft Fwd Vt	.032	.038	.249	.030	.048	.035
	Rt Fwd Vt	.033	.042	.187	.079	.029	.035
	Center Vt	.033	.037	.235	.056	.046	.050
	Center Long.	.005	.055	.079	.010	.010	.006
100	Lft Fwd Vt	.031	.036	.289	.034	.069	.058
	Rt Fwd Vt	.028	.024	.114	.101	.040	.077
	Center Vt	.034	.035	.189	.018	.056	.063
	Center Long.	.005	.003	.113	.006	.018	.069
102	Lft Fwd Vt	.026	.029	.261	.063	.063	.057
	Rt Fwd Vt	.022	.024	.029	.097	.040	.064
	Center Vt	.023	.026	.121	.002	.043	.095
	Center Long.	.003	.001	.098	.010		.016

TABLE XII - Continued							
Pivot Configuration - Rubber							
50-Pound Platform 120 Knots							
Main Rotor Speed (% RPM)	Pickup Location	Main Rotor Harmonic Vibration Level(±g)					
		One/Rev		Four/Rev		Eight/Rev	
		Input	Output	Input	Output	Input	Output
92	Lft Fwd Vt	.053	.061	.046	.021	.002	.007
	Rt Fwd Vt	.055	.059	.033	.018	.062	.068
	Center Vt	.058	.056	.049	.017	.040	.011
	Center Long.	.004	.005	.106	.046	.052	.086
94	Lft Fwd Vt	.017	.018	.028	.010	.014	.010
	Rt Fwd Vt	.016	.014	.008	.024	.044	.042
	Center Vt	.018	.020	.017	.007	.040	.017
	Center Long.	.008	.007	.093	.030	.045	.071
96	Lft Fwd Vt	.010	.012	.072	.018	.029	.023
	Rt Fwd Vt	.016	.017	.069	.005	.042	.062
	Center Vt	.013	.011	.088	.030	.035	.011
	Center Long.	.005	.011	.125	.029	.042	.040
98	Lft Fwd Vt	.018	.028	.086	.022	.039	.022
	Rt Fwd Vt	.022	.028	.080	.021	.039	.058
	Center Vt	.022	.024	.105	.041	.032	.023
	Center Long.	.010	.011	.138	.035	.043	.083
100	Lft Fwd Vt	.027	.032	.116	.003	.039	.050
	Rt Fwd Vt	.031	.038	.098	.026	.026	.071
	Center Vt	.035	.034	.124	.027	.024	.027
	Center Long.	.012	.014	.154	.037	.024	.122
102	Lft Fwd Vt	.013	.013	.067	.027	.013	.024
	Rt Fwd Vt	.013	.021	.090	.014	.006	.051
	Center Vt	.015	.016	.088	.029	.005	.033
	Center Long.	.009	.012	.148	.017	.022	.107

TABLE XII - Continued

Pivot Configuration - Rubber

150-Pound Platform 30 Knots

Main Rotor Speed (% RPM)	Pickup Location	Main Rotor Harmonic Vibration Level (±g) One/Rev Input	One/Rev Output	Four/Rev Input	Four/Rev Output	Eight/Rev Input	Eight/Rev Output
92	Lft Fwd Vt	-	.032	-	.294	-	.024
	Rt Fwd Vt	.027	.037	.240	.132	.035	.012
	Center Vt	.035	.040	.300	.032	.039	.018
	Center Long.	.006	.002	.142	.053	.022	.013
94	Lft Fwd Vt	.014	.025	.246	.254	.072	.002
	Rt Fwd Vt	.016	.025	.262	.157	.047	.024
	Center Vt	.021	.022	.330	.053	.074	.031
	Center Long.	.008	.006	.123	.050	.007	.022
96	Lft Fwd Vt	.025	.031	.197	.068	.021	.011
	Rt Fwd Vt	.025	.029	.174	.158	.020	.019
	Center Vt	.026	.031	.224	.042	.024	.016
	Center Long.	.005	.004	.105	.037	.009	.010
98	Lft Fwd Vt	.016	.019	.102	.046	.008	.005
	Rt Fwd Vt	.018	.015	.069	.100	.003	.005
	Center Vt	.014	.015	.093	.030	.010	.004
	Center Long.	.003	.005	.046	.010	.002	.006
100	Lft Fwd Vt	.020	.025	.187	.135	.040	.030
	Rt Fwd Vt	.025	.031	.118	.183	.025	.006
	Center Vt	.025	.029	.154	.060	.048	.010
	Center Long.	.005	.007	.115	.014	.009	.001
102	Lft Fwd Vt	.025	.032	.151	.204	.027	.024
	Rt Fwd Vt	.021	.031	.058	.160	.003	.012
	Center Vt	.026	.030	.091	.053	.013	.010
	Center Long.	.003	.002	.095	.010	.007	.007

TABLE XII - Continued							
Pivot Configuration - Rubber							
150-Pound Platform 120 Knots							
Main Rotor Speed (% RPM)	Pickup Location	Main Rotor Harmonic Vibration Level (±g)					
		One/Rev		Four/Rev		Eight/Rev	
		Input	Output	Input	Output	Input	Output
98	Lft Fwd Vt	.015	.008	.068	.070	.024	.002
	Rt Fwd Vt	.015	.023	.061	.031	.027	.027
	Center Vt	.019	.019	.088	.051	.026	.037
	Center Long.	.005	.014	.120	.016	.025	.028
100	Lft Fwd Vt	.060	.044	.198	.091	.143	.032
	Rt Fwd Vt	.019	.027	.094	.038	.006	.012
	Center Vt	.016	.025	.106	.053	.019	.020
	Center Long.	.010	.019	.131	.030	.007	.011
102	Lft Fwd Vt	.012	.016	.093	.013	.027	.009
	Rt Fwd Vt	.007	.022	.084	.052	.031	.017
	Center Vt	.010	.006	.098	.051	.032	.003
	Center Long.	.014	.024	.157	.023	.028	.008
200-Pound Platform 30 Knots							
92	Lft Fwd Vt	.024	.021	.117	.339	.024	.136
	Rt Fwd	.022	.025	.203	.112	.010	.047
	Center Vt	.020	.028	.240	.073	.020	.025
	Center Long.	.004	.006	.162	.064	.008	.012
94	Lft Fwd Vt	.028	.027	.193	.260	.042	.071
	Rt Fwd Vt	.023	.027	.223	.175	.036	.038
	Center Vt	.023	.028	.282	.043	.047	.034
	Center Long.	.006	.008	.137	.060	.009	.012
96	Lft Fwd Vt	.042	.049	.245	.052	.043	.048
	Rt Fwd Vt	.037	.054	.182	.255	.041	.032
	Center Vt	.044	.049	.257	.034	.054	.021
	Center Long.	.005	.002	.095	.049	.020	.008

TABLE XII - Continued

Pivot Configuration - Rubber

Main Rotor Speed (% RPM)	Pickup Location	Main Rotor Harmonic Vibration Level (±g)					
		One/Rev		Four/Rev		Eight/Rev	
		Input	Output	Input	Output	Input	Output
200-Pound Platform 30 Knots							
98	Lft Fwd Vt	.033	.045	.264	.118	.048	.041
	Rt Fwd Vt	.031	.045	.157	.226	.023	.032
	Center Vt	.032	.045	.225	.018	.039	.019
	Center Long.	.005	.003	.122	.028	.018	.007
100	Lft Fwd Vt	.029	.034	.198	.211	.052	.045
	Rt Fwd Vt	.020	.028	.118	.125	.024	.038
	Center Vt	.027	.034	.144	.061	.040	.020
	Center Long.	.003	.008	.082	.029	.021	.021
102	Lft Fwd Vt	.038	.044	.271	.266	.080	.080
	Rt Fwd Vt	.028	.041	.154	.138	.039	.054
	Center Vt	.036	.043	.194	.090	.066	.029
	Center Long.	.007	.007	.122	.038	.043	.031
200-Pound Platform 120 Knots							
94	Lft Fwd Vt	.007	.006	.048	.096	.025	.046
	Rt Fwd Vt	.002	.005	.056	.024	.039	.003
	Center Vt	.005	.005	.067	.043	.035	.034
	Center Long.	.012	.014	.112	.009	.044	.026
96	Lft Fwd Vt	.024	.036	.107	.161	.032	.023
	Rt Fwd Vt	.026	.027	.098	.072	.035	.015
	Center Vt	.027	.033	.135	.061	.039	.037
	Center Long.	.007	.010	.144	.015	.058	.020
98	Lft Fwd Vt	.023	.026	.140	.143	.044	.024
	Rt Fwd Vt	.024	.035	.127	.115	.031	.005
	Center Vt	.024	.029	.171	.071	.043	.030
	Center Long.	.015	.020	.168	.017	.054	.012

TABLE XII - Continued

Pivot Configuration - Rubber

Main Rotor Speed (% RPM)	Pickup Location	Main Rotor Harmonic Vibration Level (±g)					
		One/Rev		Four/Rev		Eight/Rev	
		Input	Output	Input	Output	Input	Output
200-Pound Platform 120 Knots							
100	Lft Fwd Vt	.028	.024	.111	.116	.036	.016
	Rt Fwd Vt	.026	.034	.094	.115	.019	.007
	Center Vt	.025	.027	.127	.076	.029	.017
	Center Long.	.014	.021	.162	.023	.026	.009
102	Lft Fwd Vt	.029	.032	.076	.102	.039	.021
	Rt Fwd Vt	.029	.032	.101	.100	.019	.029
	Center Vt	.031	.034	.103	.082	.038	.012
	Center Long.	.018	.019	.143	.027	.027	.006
200-Pound Platform With 3-Inch CG Offset 30 Knots							
92	Lft Fwd Vt	.011	.012	.046	.162	.022	.017
	Rt Fwd Vt	.007	.013	.141	.193	.018	.019
	Center Vt	.011	.011	.165	.156	.025	.026
	Center Long.	.001	.003	.129	.060	.010	.009
94	Lft Fwd Vt	.032	.039	.229	.292	.057	.091
	Rt Fwd Vt	.028	.037	.292	.405	.053	.038
	Center Vt	.026	.038	.348	.198	.070	.019
	Center Long.	.003	.003	.156	.100	.006	.002
96	Lft Fwd Vt	.036	.043	.157	.133	.029	.017
	Rt Fwd Vt	.030	.040	.201	.169	.039	.009
	Center Vt	.035	.042	.225	.082	.041	.010
	Center Long.	.006	.010	.107	.066	.015	.008
98	Lft Fwd Vt	.056	.027	.062	.077	.115	.013
	Rt Fwd Vt	.031	.023	.101	.066	.039	.009
	Center Vt	.030	.029	.142	.058	.029	.018
	Center Long.	.004	.007	.097	.053	.017	.004

TABLE XII - Continued							
Pivot Configuration - Rubber							
200-Pound Platform With 3-Inch CG Offset 30 Knots							
Main Rotor Speed (% RPM)	Pickup Location	Main Rotor Harmonic Vibration Level (±g)					
		One/Rev		Four/Rev		Eight/Rev	
		Input	Output	Input	Output	Input	Output
100	Lft Fwd Vt	.035	.037	.102	.053	.029	.033
	Rt Fwd Vt	.037	.029	.107	.073	.016	.007
	Center Vt	.031	.037	.096	.058	.022	.012
	Center Long.	.005	.002	.053	.050	.011	.010
102	Lft Fwd Vt	.020	.026	.077	.036	.017	.015
	Rt Fwd Vt	.019	.028	.089	.062	.011	.008
	Center Vt	.020	.026	.066	.065	.008	.001
	Center Long.	.006	.008	.043	.044	.004	.004
200-Pound Platform With 3-Inch CG Offset 120 Knots							
96	Lft Fwd Vt	.031	.038	.079	.086	.033	.054
	Rt Fwd Vt	.033	.037	.094	.069	.024	.025
	Center Vt	.031	.042	.119	.086	.026	.017
	Center Long.	.006	.009	.121	.005	.039	.010
98	Lft Fwd Vt	.024	.029	.129	.122	.036	.060
	Rt Fwd Vt	.027	.034	.135	.142	.045	.022
	Center Vt	.029	.035	.157	.117	.043	.025
	Center Long.	.011	.008	.159	.018	.050	.018
100	Lft Fwd Vt	.018	.019	.089	.132	.046	.035
	Rt Fwd Vt	.018	.029	.119	.140	.030	.004
	Center Vt	.017	.025	.126	.127	.026	.009
	Center Long.	.014	.022	.162	.035	.030	.004
102	Lft Fwd Vt	.033	.033	.093	.124	.048	.023
	Rt Fwd Vt	.028	.033	.135	.154	.013	.014
	Center Vt	.033	.034	.123	.111	.033	.011
	Center Long.	.008	.011	.171	.024	.026	.012

TABLE XII - Continued							
Pivot Configuration - Lateral Offset Bendix Flexural							
50-Pound Platform				30 Knots			
Main Rotor Speed (% RPM)	Pickup Location	Main Rotor Harmonic Vibration Level ($\pm$g)					
		One/Rev		Four/Rev		Eight/Rev	
		Input	Output	Input	Output	Input	Output
92	Lft Fwd Vt	.030	.029	.097	.147	.040	.033
	Rt Fwd Vt	.028	.037	.173	.266	.015	.051
	Center Vt	.031	.030	.198	.202	.023	.026
	Center Long.	.007	.007	.137	.382	.004	.008
94	Lft Fwd Vt	.018	.031	.134	.056	.038	.026
	Rt Fwd Vt	.016	.020	.138	.187	.033	.028
	Center Vt	.019	.019	.177	.140	.037	.022
	Center Long.	.007	.001	.079	.111	.013	.017
96	Lft Fwd Vt	.021	.023	.158	.057	.027	.014
	Rt Fwd Vt	.024	.027	.149	.169	.018	.018
	Center Vt	.019	.023	.177	.127	.030	.016
	Center Long.	.015	.006	.067	.043	.007	.008
98	Lft Fwd Vt	.027	.031	.188	.185	.046	.006
	Rt Fwd Vt	.026	.032	.089	.245	.039	.022
	Center Vt	.030	.034	.144	.095	.052	.021
	Center Long.	.002	.004	.054	.008	.012	.017
100	Lft Fwd Vt	.052	.055	.214	.918	.035	.008
	Rt Fwd Vt	.043	.054	.168	1.097	.016	.002
	Center Vt	.049	.053	.140	.136	.031	.046
	Center Long.	.008	.007	.098	.066	.019	.003
102	Lft Fwd Vt	.034	.045	.166	.534	.039	.027
	Rt Fwd Vt	.034	.043	.131	.649	.038	.021
	Center Vt	.037	.044	.125	.116	.034	.041
	Center Long.	.004	.008	.123	.080	.026	.008

TABLE XII - Continued							
Pivot Configuration - Longitudinal Offset Bendix Flexural							
50-Pound Platform				30 Knots			
Main Rotor Speed (% RPM)	Pickup Location	Main Rotor Harmonic Vibration Level (±g)					
		One/Rev		Four/Rev		Eight/Rev	
		Input	Output	Input	Output	Input	Output
92	Lft Fwd Vt	.018	.024	.166	.189	.024	.020
	Rt Fwd Vt	.016	.023	.121	.137	.013	.021
	Center Vt	.017	.024	.204	.140	.022	.012
	Center Long.	.004	.002	.146	.085	.005	.010
94	Lft Fwd Vt	.016	.015	.150	.053	.039	.008
	Rt Fwd Vt	.013	.015	.125	.070	.031	.009
	Center Vt	.014	.013	.177	.066	.039	.006
	Center Long.	.004	.003	.079	.090	.012	.010
96	Lft Fwd Vt	.027	.032	.231	.027	.024	.028
	Rt Fwd Vt	.028	.034	.200	.121	.033	.020
	Center Vt	.029	.029	.248	.085	.051	.015
	Center Long.	.007	.011	.096	.160	.006	.013
98	Lft Fwd Vt	.025	.027	.163	.015	.032	.015
	Rt Fwd Vt	.022	.025	.126	.121	.029	.012
	Center Vt	.023	.019	.151	.101	.041	.012
	Center Long.	.002	.022	.097	.175	.017	.014
100	Lft Fwd Vt	.027	.035	.232	.020	.052	.042
	Rt Fwd Vt	.027	.033	.188	.190	.053	.051
	Center Vt	.027	.024	.207	.139	.071	.054
	Center Long.	.006	.005	.098	.229	.017	.027
102	Lft Fwd Vt	.036	.047	.220	.033	.040	.028
	Rt Fwd Vt	.033	.041	.090	.225	.035	.026
	Center Vt	.037	.042	.117	.187	.039	.032
	Center Long.	.004	.005	.121	.256	.025	.018

TABLE XII - Continued

Pivot Configuration - Lateral Offset Bendix Flexural

50-Pound Platform 120 Knots

Main Rotor Speed (% RPM)	Pickup Location	Main Rotor Harmonic Vibration Level (±g) One/Rev Input	One/Rev Output	Four/Rev Input	Four/Rev Output	Eight/Rev Input	Eight/Rev Output
92	Lft Fwd Vt	.015	.006	.036	.030	.036	.041
	Rt Fwd Vt	.012	.021	.037	.076	.020	.019
	Center Vt	.016	.013	.024	.069	.028	.011
	Center Long.	.010	.013	.089	.251	.049	.033
94	Lft Fwd Vt	.016	.019	.089	.096	.037	.032
	Rt Fwd Vt	.018	.020	.078	.038	.035	.013
	Center Vt	.022	.021	.103	.005	.035	.014
	Center Long.	.009	.020	.119	.199	.039	.036
96	Lft Fwd Vt	.011	.014	.068	.070	.035	.014
	Rt Fwd Vt	.007	.007	.074	.059	.024	.017
	Center Vt	.010	.015	.085	.027	.030	.008
	Center Long.	.009	.017	.115	.122	.029	.022
98	Lft Fwd Vt	.016	.013	.079	.113	.037	.014
	Rt Fwd Vt	.011	.020	.099	.131	.007	.002
	Center Vt	.015	.011	.116	.061	.024	.014
	Center Long.	.011	.009	.134	.059	.019	.016
100	Lft Fwd Vt	.014	.014	.080	.143	.024	.008
	Rt Fwd Vt	.015	.021	.114	.124	.014	.005
	Center Vt	.017	.018	.118	.033	.021	.013
	Center Long.	.017	.016	.142	.028	.020	.019
102	Lft Fwd Vt	.023	.019	.067	.114	.025	.022
	Rt Fwd Vt	.013	.022	.097	.057	.011	.022
	Center Vt	.020	.020	.109	.034	.021	.006
	Center Long.	.015	.022	.138	.049	.041	.012

TABLE XII - Continued							
Pivot Configuration - Lateral Offset Bendix Flexural							
150-Pound Platform		30 Knots					
Main Rotor Speed (% RPM)	Pickup Location	Main Rotor Harmonic Vibration Level (±g)					
		One/Rev		Four/Rev		Eight/Rev	
		Input	Output	Input	Output	Input	Output
92	Lft Fwd Vt	.034	.042	.163	.179	.055	.075
	Rt Fwd Vt	.029	.046	.140	.321	.015	.088
	Center Vt	.031	.039	.226	.091	.017	.031
	Center Long.	.003	.004	.161	.219	.002	.010
94	Lft Fwd Vt	.022	.031	.239	.483	.065	.207
	Rt Fwd Vt	.019	.038	.028	.605	.030	.133
	Center Vt	.024	.031	.275	.096	.048	.047
	Center Long.	.005	.006	.138	.098	.002	.021
96	Lft Fwd Vt	.015	.015	.211	.741	.034	.078
	Rt Fwd Vt	.008	.016	.182	.847	.035	.131
	Center Vt	.009	.014	.221	.096	.037	.019
	Center Long.	.004	.002	.104	.040	.011	.003
98	Lft Fwd Vt	.025	.027	.042	.162	.012	.029
	Rt Fwd Vt	.025	.027	.034	.203	.005	.029
	Center Vt	.026	.030	.038	.039	.003	.005
	Center Long.	.008	.011	.028	.018	.011	.008
100	Lft Fwd Vt	.032	.040	.062	.234	.009	.027
	Rt Fwd Vt	.030	.044	.080	.262	.015	.019
	Center Vt	.032	.040	.078	.021	.013	.010
	Center Long.	.005	.011	.025	.029	.001	.006
102	Lft Fwd Vt	.040	.051	.059	.119	.008	.033
	Rt Fwd Vt	.047	.051	.023	.109	.022	.048
	Center Vt	.037	.037	.064	.065	.014	.008
	Center Long.	.005	.005	.019	.009	.003	.009

TABLE XII - Continued							
Pivot Configuration - Lateral Offset Bendix Flexural							
150-Pound Platform				120 Knots			
Main Rotor Speed (% RPM)	Pickup Location	Main Rotor Harmonic Vibration Level ($\pm g$)					
		One/Rev		Four/Rev		Eight/Rev	
		Input	Output	Input	Output	Input	Output
92	Lft Fwd Vt	.003	.005	.041	.203	.012	.048
	Rt Fwd Vt	.008	.012	.071	.259	.043	.042
	Center Vt	.003	.001	.072	.041	.025	.002
	Center Long.	.010	.016	.104	.148	.056	.008
94	Lft Fwd Vt	.019	.020	.004	.225	.016	.069
	Rt Fwd Vt	.016	.029	.037	.235	.035	.054
	Center Vt	.022	.025	.025	.029	.029	.007
	Center Long.	.013	.014	.090	.080	.048	.009
96	Lft Fwd Vt	.032	.029	.067	.321	.020	.073
	Rt Fwd Vt	.031	.039	.068	.329	.038	.035
	Center Vt	.029	.034	.087	.046	.027	.008
	Center Long.	.010	.026	.105	.064	.030	.003
98	Lft Fwd Vt	.008	.013	.083	.689	.015	.062
	Rt Fwd Vt	.011	.013	.073	.795	.043	.095
	Center Vt	.012	.014	.095	.059	.029	.025
	Center Long.	.009	.018	.126	.077	.028	.005
100	Lft Fwd Vt	.016	.025	.104	.289	.025	.014
	Rt Fwd Vt	.019	.025	.104	.363	.013	.050
	Center Vt	.017	.025	.124	.045	.015	.010
	Center Long.	.011	.028	.145	.055	.009	.002
102	Lft Fwd Vt	.031	.040	.105	.123	.038	.004
	Rt Fwd Vt	.035	.048	.100	.162	.023	.091
	Center Vt	.037	.040	.120	.032	.014	.025
	Center Long.	.013	.018	.164	.026	.021	.013

TABLE XII - Continued

Pivot Configuration - Lateral Offset Bendix Flexural

200-Pound Platform 30 Knots

Main Rotor Speed (% RPM)	Pickup Location	Main Rotor Harmonic Vibration Level ($\pm g$)					
		One/Rev		Four/Rev		Eight/Rev	
		Input	Output	Input	Output	Input	Output
92	Lft Fwd Vt	.022	.032	.137	.201	.095	.239
	Rt Fwd Vt	.020	.028	.145	.091	.019	.201
	Center Vt	.022	.030	.208	.048	.031	.007
	Center Long.	.006	.010	.142	.176	.015	.011
94	Lft Fwd Vt	.023	.040	.287	.182	.056	.315
	Rt Fwd Vt	.017	.039	.282	.104	.101	.416
	Center Vt	.023	.040	.362	.047	.079	.032
	Center Long.	.005	.018	.161	.125	.009	.013
96	Lft Fwd Vt	.022	.035	.226	.078	.060	.300
	Rt Fwd Vt	.021	.035	.280	.054	.043	.034
	Center Vt	.001	.005	.071	.040	.007	.231
	Center Long.	.007	.006	.118	.088	.007	.005
98	Lft Fwd Vt	.011	.009	.201	.124	.031	.016
	Rt Fwd Vt	.010	.014	.176	.062	.041	.257
	Center Vt	.012	.016	.206	.052	.043	.040
	Center Long.	.005	.001	.106	.054	.003	.015
100	Lft Fwd Vt	.028	.044	.044	.082	.035	.033
	Rt Fwd Vt	.026	.043	.046	.018	.022	.034
	Center Vt	.028	.047	.047	.010	.027	.007
	Center Long.	.005	.010	.011	.009	.016	.005
102	Lft Fwd Vt	.030	.043	.027	.015	.008	.003
	Rt Fwd Vt	.027	.046	.014	.009	.002	.014
	Center Vt	.030	.043	.021	.010	.004	.001
	Center Long.	.004	.013	.002	.009	.008	.006

TABLE XII - Continued							
Pivot Configuration - Lateral Offset Bendix Flexural							
200-Pound Platform				120 Knots			
Main Rotor Speed (% RPM)	Pickup Location	Main Rotor Harmonic Vibration Level (±g)					
		One/Rev		Four/Rev		Eight/Rev	
		Input	Output	Input	Output	Input	Output
92	Lft Fwd Vt	.012	.011	.047	.158	.032	.102
	Rt Fwd Vt	.010	.020	.047	.081	.062	.144
	Center Vt	.012	.015	.036	.037	.029	.012
	Center Long.	.009	.015	.124	.156	.041	.017
94	Lft Fwd Vt	.016	.021	.057	.044	.014	.081
	Rt Fwd Vt	.018	.021	.061	.047	.059	.174
	Center Vt	.019	.020	.070	.034	.034	.020
	Center Long.	.006	.027	.109	.094	.032	.011
96	Lft Fwd Vt	.016	.011	.082	.056	.040	.125
	Rt Fwd Vt	.018	.016	.077	.039	.080	.321
	Center Vt	.018	.021	.094	.058	.031	.045
	Center Long.	.006	.024	.125	.075	.032	.007
98	Lft Fwd Vt	.011	.008	.089	.071	.057	.066
	Rt Fwd Vt	.013	.010	.076	.038	.059	.333
	Center Vt	.012	.009	.100	.046	.023	.050
	Center Long.	.009	.054	.158	.052	.011	.008
100	Lft Fwd Vt	.022	.039	.118	.067	.043	.057
	Rt Fwd Vt	.027	.052	.105	.034	.017	.102
	Center Vt	.026	.049	.130	.046	.023	.050
	Center Long.	.009	.054	.154	.052	.011	.008
102	Lft Fwd Vt	.009	.011	.112	.085	.039	.058
	Rt Fwd Vt	.016	.014	.105	.038	.017	.013
	Center Vt	.021	.014	.124	.053	.027	.011
	Center Long.	.012	.076	.167	.017	.032	.014

TABLE XII - Continued							
Pivot Configuration - Lateral Offset Bendix Flexural							
200-Pound Platform With 3-Inch CG Offset 30 Knots							
Main Rotor Speed (% RPM)	Pickup Location	Main Rotor Harmonic Vibration Level ($\pm g$)					
		One/Rev		Four/Rev		Eight/Rev	
		Input	Output	Input	Output	Input	Output
92	Lft Fwd Vt	.024	.041	.095	.120	.035	.107
	Rt Fwd Vt	.022	.036	.121	.057	.014	.089
	Center Vt	.024	.041	.168	.111	.023	.007
	Center Long.	.008	.008	.162	.035	.002	.032
94	Lft Fwd Vt	.033	.052	.214	.100	.042	.128
	Rt Fwd Vt	.027	.042	.224	.066	.031	.134
	Center Vt	.034	.050	.286	.104	.033	.022
	Center Long.	.001	.015	.150	.051	.007	.035
96	Lft Fwd Vt	.029	.048	.187	.079	.042	.063
	Rt Fwd Vt	.024	.031	.164	.072	.032	.071
	Center Vt	.024	.032	.204	.086	.041	.013
	Center Long.	.004	.015	.094	.054	.011	.016
98	Lft Fwd Vt	.012	.024	.096	.072	.011	.044
	Rt Fwd Vt	.015	.020	.084	.057	.013	.038
	Center Vt	.014	.022	.098	.075	.013	.021
	Center Long.	.002	.005	.038	.034	.007	.007
100	Lft Fwd Vt	.035	.057	.112	.078	.002	.067
	Rt Fwd Vt	.029	.049	.119	.072	.043	.088
	Center Vt	.030	.057	.127	.085	.031	.037
	Center Long.	.004	.011	.090	.123	.029	.033
102	Lft Fwd Vt	.040	.059	.106	.086	.043	.110
	Rt Fwd Vt	.030	.046	.110	.081	.037	.181
	Center Vt	.033	.054	.107	.090	.035	.038
	Center Long.	.005	.018	.094	.066	.026	.052

TABLE XII - Continued							
Pivot Configuration - Lateral Offset Bendix Flexural							
200-Pound Platform With 3-Inch CG Offset 120 Knots							
Main Rotor Speed (% RPM)	Pickup Location	Main Rotor Harmonic Vibration Level (±g)					
		One/Rev		Four/Rev		Eight/Rev	
		Input	Output	Input	Output	Input	Output
92	Lft Fwd Vt	.020	.029	.022	.057	.007	.040
	Rt Fwd Vt	.018	.026	.055	.047	.028	.036
	Center Vt	.024	.028	.050	.068	.026	.007
	Center Long.	.005	.017	.104	.035	.060	.019
94	Lft Fwd Vt	.029	.039	.011	.021	.021	.033
	Rt Fwd Vt	.034	.044	.018	.020	.031	.024
	Center Vt	.036	.046	.017	.015	.020	.007
	Center Long.	.013	[illegible]	.089	.038	.039	.018
96	Lft Fwd Vt	.013	.013	.097	.056	.038	.038
	Rt Fwd Vt	.017	.030	.091	.035	.041	.072
	Center Vt	.014	.026	.118	.063	.026	[illegible]
	Center Long.	.010	.034	.140	.051	.025	[illegible]
98	Lft Fwd Vt	.012	.037	.095	.056	.070	.131
	Rt Fwd Vt	.010	.032	.119	.040	.024	.054
	Center Vt	.013	.035	.126	.057	.022	.025
	Center Long.	.009	.037	.147	.038	.014	.021
100	Lft Fwd Vt	.004	.033	.094	.072	.084	.176
	Rt Fwd Vt	.013	.030	.094	.036	.006	.073
	Center Vt	.014	.028	.099	.060	.028	.015
	Center Long.	.015	.046	.143	.039	.031	.003
102	Lft Fwd Vt	.035	.043	.090	.067	.126	.517
	Rt Fwd Vt	.036	.047	.099	.030	.038	.323
	Center Vt	.033	.046	.104	.060	.033	.037
	Center Long.	.009	.037	.149	.021	.033	.068

TABLE XII - Continued							
Pivot Configuration - Longitudinal Offset of Bendix Flexural							
50-Pound Platform							120 Knots
Main Rotor Speed (% RPM)	Pickup Location	Main Rotor Harmonic Vibration Level(±g)					
		One/Rev		Four/Rev		Eight/Rev	
		Input	Output	Input	Output	Input	Output
92	Lft Fwd Vt	.022	.021	.047	.031	.025	.040
	Rt Fwd Vt	.022	.035	.032	.059	.008	.032
	Center Vt	.025	.026	.040	.048	.016	.036
	Center Long.	.020	.019	.082	.040	.034	.029
94	Lft Fwd Vt	.020	.019	.082	.040	.034	.029
	Rt Fwd Vt	.023	.028	.057	.055	.025	.039
	Center Vt	.023	.026	.082	.073	.037	.036
	Center Long.	.009	.012	.112	.094	.031	.002
96	Lft Fwd Vt	.010	.019	.115	.021	.045	.016
	Rt Fwd Vt	.019	.017	.076	.083	.035	.041
	Center Vt	.011	.015	.119	.077	.030	.027
	Center Long.	.017	.013	.136	.151	.035	.007
98	Lft Fwd Vt	.019	.015	.122	.002	.060	.018
	Rt Fwd Vt	.017	.018	.082	.098	.021	.047
	Center Vt	.019	.019	.123	.091	.037	.041
	Center Long.	.010	.011	.145	.188	.039	.015
100	Lft Fwd Vt	.017	.021	.122	.025	.024	.012
	Rt Fwd Vt	.026	.027	.084	.129	.013	.030
	Center Vt	.034	.032	.117	.164	.023	.007
	Center Long.	.022	.027	.155	.292	.010	.021
102	Lft Fwd Vt	.016	.028	.140	.057	.029	.008
	Rt Fwd Vt	.022	.026	.101	.178	.022	.035
	Center Vt	.024	.022	.117	.077	.033	.031
	Center Long.	.012	.014	.163	.287	.030	.012

TABLE XII - Continued							
Pivot Configuration - Longitudinal Offset Bendix Flexural							
150-Pound Platform							30 Knots
Main Rotor Speed (% RPM)	Pickup Location	Main Rotor Harmonic Vibration Level (±g)					
		One/Rev		Four/Rev		Eight/Rev	
		Input	Output	Input	Output	Input	Output
92	Lft Fwd Vt	.010	.009	.113	.265	.030	.039
	Rt Fwd Vt	.009	.014	.092	.131	.007	.041
	Center Vt	.012	.014	.133	.013	.024	.061
	Center Long.	.002	.006	.109	.095	.008	.031
94	Lft Fwd Vt	.008	.015	.128	.112	.023	.024
	Rt Fwd Vt	.005	.013	.101	.080	.024	.023
	Center Vt	.009	.016	.149	.031	.023	.044
	Center Long.	.004	.022	.088	.035	.006	.020
96	Lft Fwd Vt	.008	.014	.215	.068	.045	.050
	Rt Fwd Vt	.007	.011	.100	.548	.025	.050
	Center Vt	.010	.013	.176	.372	.032	.045
	Center Long.	.003	.013	.077	.231	.009	.018
98	Lft Fwd Vt	.014	.010	.172	.081	.036	.012
	Rt Fwd Vt	.008	.007	.084	.228	.027	.006
	Center Vt	.008	.009	.136	.198	.034	.012
	Center Long.	.010	.009	.073	.113	.024	.010
100	Lft Fwd Vt	.020	.029	.092	.037	.030	.014
	Rt Fwd Vt	.017	.029	.058	.090	.026	.010
	Center Vt	.019	.027	.076	.087	.030	.006
	Center Long.	.006	.004	.033	.051	.019	.005
102	Lft Fwd Vt	.039	.048	.018	.022	.005	.002
	Rt Fwd Vt	.035	.051	.013	.047	.004	.002
	Center Vt	.032	.054	.015	.032	.006	.002
	Center Long.	.002	.001	.004	.015	.002	.003

TABLE XII - Continued							
Pivot Configuration - Longitudinal Offset Bendix Flexural							
150-Pound Platform				120 Knots			
Main Rotor Speed (% RPM)	Pickup Location	Main Rotor Harmonic Vibration Level (±g)					
		One/Rev		Four/Rev		Eight/Rev	
		Input	Output	Input	Output	Input	Output
92	Lft Fwd Vt	.011	.015	.110	.179	.015	.031
	Rt Fwd Vt	.012	.017	.024	.050	.017	.039
	Center Vt	.011	.016	.066	.034	.010	.047
	Center Long.	.008	.014	.107	.084	.044	.033
94	Lft Fwd Vt	.013	.014	.051	.061	.015	.024
	Rt Fwd Vt	.009	.018	.021	.054	.036	.043
	Center Vt	.006	.010	.026	.029	.029	.049
	Center Long.	.010	.009	.076	.015	.045	.031
96	Lft Fwd Vt	.015	.026	.012	.170	.046	.057
	Rt Fwd Vt	.018	.026	.116	.670	.028	.076
	Center Vt	.018	.026	.072	.413	.027	.075
	Center Long.	.013	.014	.100	.268	.039	.041
98	Lft Fwd Vt	.007	.010	.098	.151	.040	.027
	Rt Fwd Vt	.008	.008	.113	.451	.032	.023
	Center Vt	.008	.011	.123	.275	.041	.010
	Center Long.	.008	.014	.152	.163	.030	.006
100	Lft Fwd Vt	.012	.020	.105	.122	.059	.024
	Rt Fwd Vt	.020	.027	.098	.275	.026	.013
	Center Vt	.016	.032	.116	.171	.039	.005
	Center Long.	.010	.034	.145	.080	.023	.003
102	Lft Fwd Vt	.020	.018	.098	.154	.028	.012
	Rt Fwd Vt	.018	.032	.100	.243	.019	.015
	Center Vt	.021	.027	.105	.143	.025	.013
	Center Long.	.008	.011	.012	.025	.010	.006

TABLE XII - Continued							
Pivot Configuration - Longitudinal Offset Bendix Flexural							
150-Pound Platform Redistributed Weight 30 Knots							
Main Rotor Speed (% RPM)	Pickup Location	Main Rotor Harmonic Vibration Level (±g)					
		One/Rev		Four/Rev		Eight/Rev	
		Input	Output	Input	Output	Input	Output
92	Lft Fwd Vt	.024	.027	.209	.279	.038	.040
	Rt Fwd Vt	.023	.030	.142	.454	.013	.045
	Center Vt	.022	.034	.240	.167	.031	.054
	Center Long.	.006	.007	.170	.100	.006	.015
94	Lft Fwd Vt	.014	.019	.202	.133	.033	.038
	Rt Fwd Vt	.011	.024	.144	.513	.035	.042
	Center Vt	.017	.019	.220	.234	.031	.045
	Center Long.	.003	.006	.104	.180	.006	.008
96	Lft Fwd Vt	.020	.024	.311	.139	.059	.526
	Rt Fwd Vt	.019	.019	.129	.859	.051	.598
	Center Vt	.023	.039	.258	.485	.044	.728
	Center Long.	.009	.018	.111	.371	.016	.249
98	Lft Fwd Vt	.025	.025	.260	.104	.006	.243
	Rt Fwd Vt	.017	.026	.085	.759	.013	.349
	Center Vt	.021	.021	.205	.447	.020	.423
	Center Long.	.003	.008	.101	.323	.003	.140
100	Lft Fwd Vt	.034	.034	.051	.055	.023	.030
	Rt Fwd Vt	.027	.045	.031	.078	.015	.035
	Center Vt	.030	.041	.046	.054	.015	.043
	Center Long.	.005	.015	.031	.047	.002	.010
102	Lft Fwd Vt	.037	.045	.035	.029	.022	.017
	Rt Fwd Vt	.032	.048	.026	.044	.022	.018
	Center Vt	.033	.046	.027	.042	.028	.020
	Center Long.	.005	.005	.018	.030	.021	.014

TABLE XII - Continued							
Pivot Configuration - Longitudinal Offset Bendix Flexural							
150-Pound Platform With Redistributed Weight 120 Knots							
Main Rotor Speed (% RPM)	Pickup Location	Main Rotor Harmonic Vibration Level (±g)					
		One/Rev		Four/Rev		Eight/Rev	
		Input	Output	Input	Output	Input	Output
92	Lft Fwd Vt	.023	.028	.084	.182	.009	.073
	Rt Fwd Vt	.027	.036	.022	.210	.041	.052
	Center Vt	.024	.034	.064	.030	.031	.097
	Center Long.	.008	.010	.114	.050	.057	.024
94	Lft Fwd Vt	.027	.036	.069	.086	.027	.113
	Rt Fwd Vt	.028	.041	.069	.694	.022	.106
	Center Vt	.027	.039	.043	.323	.025	.145
	Center Long.	.011	.015	.104	.268	.036	.046
96	Lft Fwd Vt	.014	.012	.034	.090	.047	.228
	Rt Fwd Vt	.015	.023	.120	.800	.024	.284
	Center Vt	.015	.020	.090	.437	.048	.355
	Center Long.	.009	.020	.115	.317	.050	.131
98	Lft Fwd Vt	.010	.010	.083	.179	.055	.089
	Rt Fwd Vt	.016	.082	.119	.797	.036	.137
	Center Vt	.011	.029	.134	.327	.053	.105
	Center Long.	.007	.022	.164	.201	.050	.050
100	Lft Fwd Vt	.013	.015	.105	.250	.059	.112
	Rt Fwd Vt	.010	.013	.110	.332	.044	.152
	Center Vt	.010	.013	.119	.238	.053	.168
	Center Long.	.017	.015	.155	.112	.052	.065
102	Lft Fwd Vt	.014	.010	.047	.474	.045	.405
	Rt Fwd Vt	.014	.016	.108	.275	.035	.460
	Center Vt	.013	.012	.095	.246	.037	.595
	Center Long.	.015	.039	.145	.082	.032	.231

the offset between the elastic axis of the springs and the isolated pivot of the DAVI inertia bar. When the two-dimensional DAVI was designed for this program, it was realized that the offset of the elastic axis of the springs from the isolated pivot would introduce a couple into the platform. It was believed that this couple would be cancelled by proper orientation of the DAVI system. However, because of the poor results obtained in flight test, which indicated the cancellation did not occur with the five-inch offset of the isolated pivot from the elastic axis as shown in Figure 87(a), further flight testing was conducted in which the offset from the isolated pivot to the spring elastic axis of each DAVI was reduced to three inches as shown in Figure 87(b). This was the maximum possible reduction without redesigning the isolators. Results did show some improvement in the isolated platform's vibration characteristics. However, overall performance remained generally poor. A twelve-degree-of-freedom rigid body analysis, including this offset, was made. It was determined that the isolated systems antiresonance in pitch and roll were nearly twice those for the vertical and in-plane translational modes. Thus, although the isolated system was tuned in the vertical and longitudinal directions to an antiresonance of 18.5 cps for the predominant four-per-rev excitation, the pitching and rolling modes of response were too near resonance, thereby causing poor performance.

COMPARISON OF THEORY AND TEST

Figures 98 through 101 show the flight test and theoretical results in the form of transmissibility in which the output accelerations on the platform were divided by the input accelerations to the platform. The test results shown are for the two-dimensional DAVI with rod-end bearings.

The theoretical results used a twelve-degree-of-freedom rigid body analysis in which the offset between the elastic axis of the springs and isolated pivot was included. Although the theory did not predict good isolation, poor agreement was obtained between theory and test. One reason for this poor correlation is that in the analysis, the effective hub forces and moments used as forcing functions can only reasonably reproduce the inputs to the isolated platform.

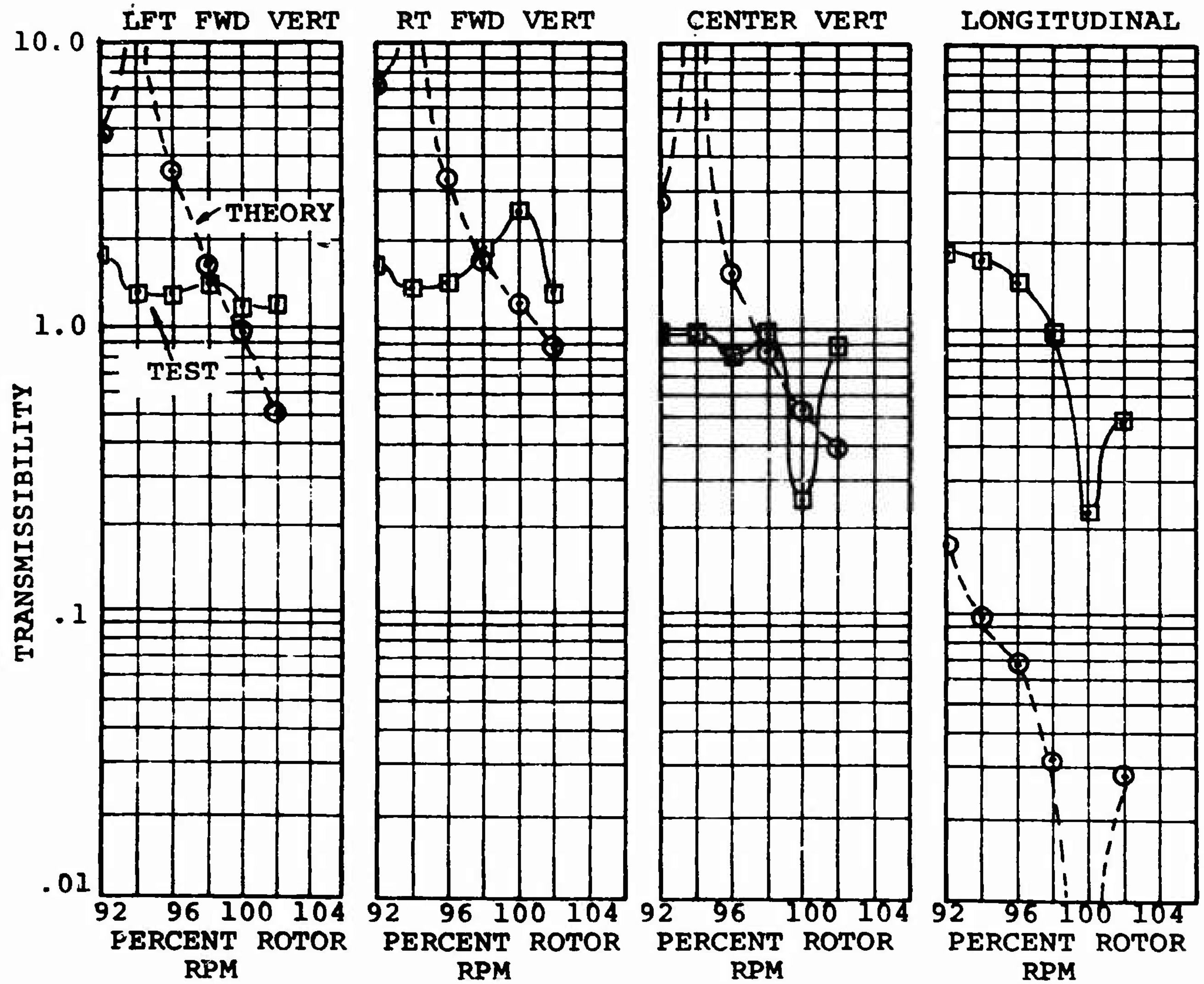


Figure 98. Transmissibility of the 50-Pound Two-Dimensional DAVI Platform at 30 Knots.

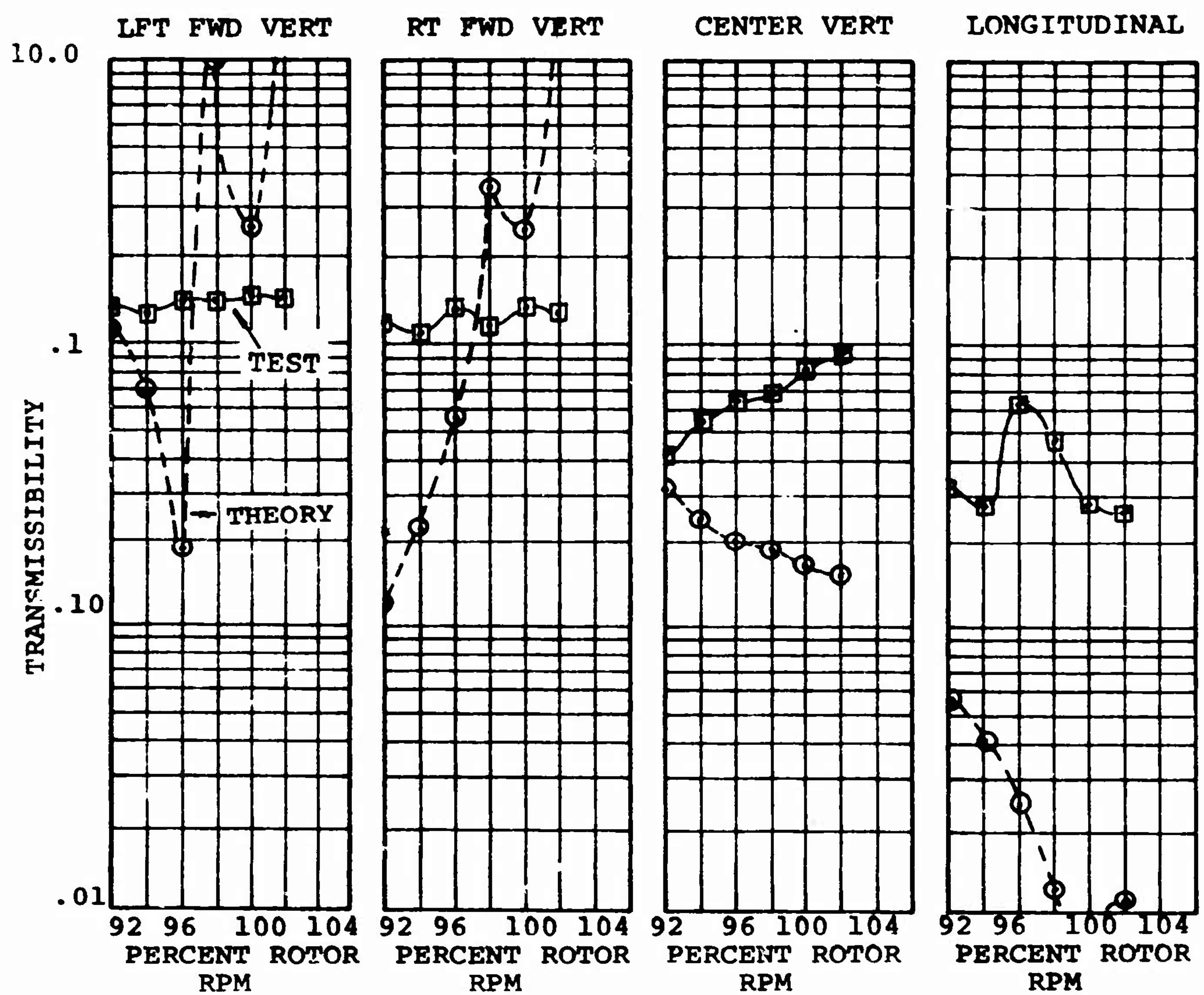


Figure 99. Transmissibility of the 150-Pound Two-Dimensional DAVI Platform at 30 Knots.

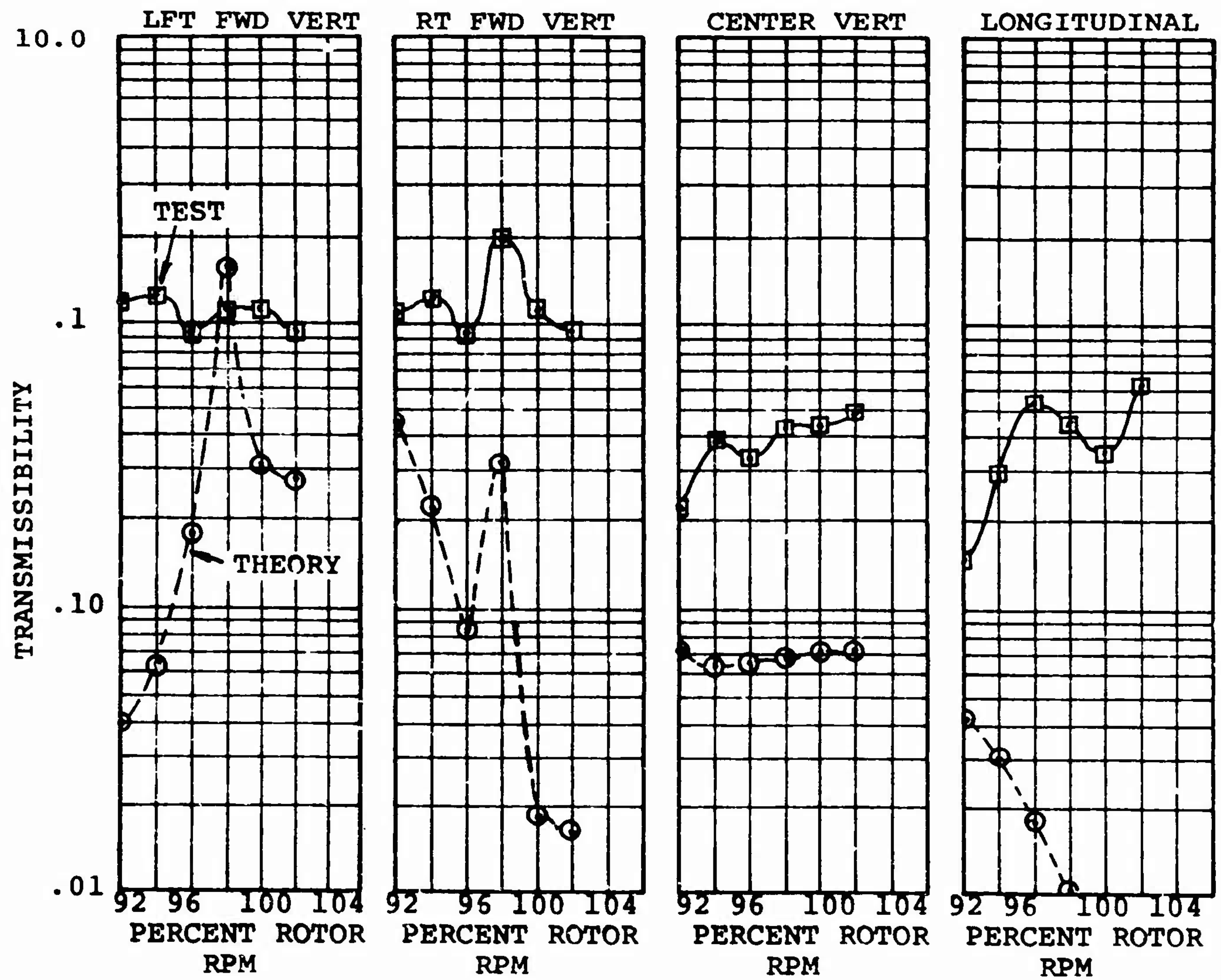


Figure 100. Transmissibility of the 200-Pound Two-Dimensional DAVI Platform at 30 Knots.

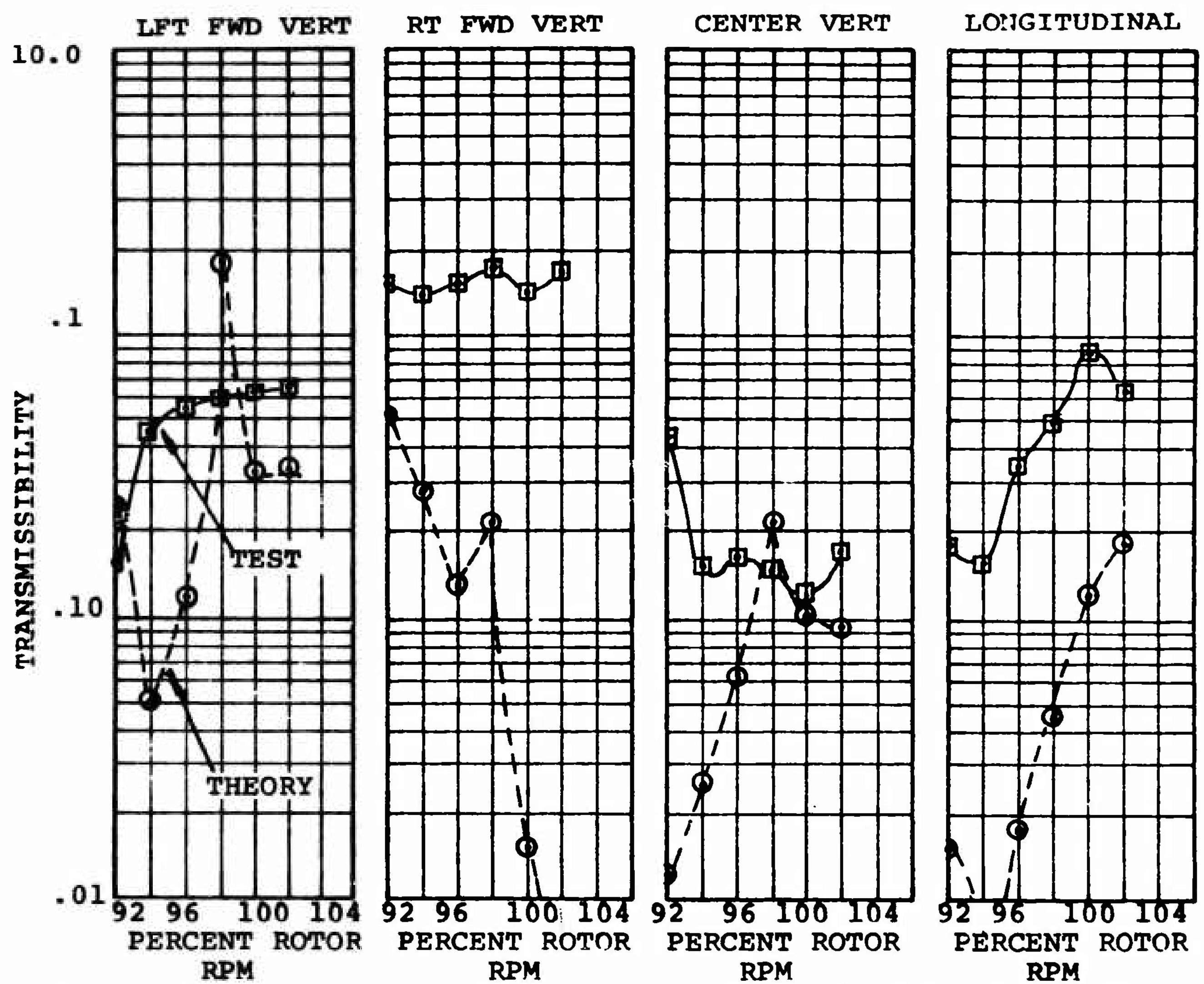


Figure 101. Transmissibility of the 200-Pound With a Three-Inch CG Offset Two-Dimensional DAVI Platform at 30 Knots.

CONCLUSIONS

This flight test program has shown that DAVI isolation is feasible when subject to actual helicopter vibratory environment. From the results of this program, the following conclusions can be made.

1. A DAVI isolation system can be designed to give isolation at a frequency where an equivalent conventional isolation system with the same static deflection is in resonance.

2. For predominant helicopter excitation frequencies, a DAVI isolation system will be less susceptible to weight change than the equivalent conventional isolation system.

3. For the four weight configurations tested, the DAVI isolation system was less susceptible to rotor rpm change than the equivalent conventional isolation systems tested.

4. A DAVI isolation system should be designed to give minimum internal coupling due to offset pivot and elastic axis.

5. For complex inputs, such as those experienced in helicopter vibratory environment, a three-dimensional DAVI isolation system is required rather than an unidirectional or two-dimensional DAVI.

6. Because of rigid body theory and the approximated input to the theory, the theoretical results did not compare with the test data, but the theory is adequate to design a DAVI isolation system.

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13. ABSTRACT

This report contains the results of a flight test evaluation of the Dynamic Antiresonant Vibration Isolator (DAVI). In this program, three series of tests were done for four different weight configurations of a DAVI isolated platform. The first series of tests evaluated the unidirectional DAVI, the second series of tests evaluated the two-dimensional DAVI, and the third series of tests evaluated the three-dimensional DAVI. The test results showed that the unidirectional and two-dimensional DAVI isolated platforms did not achieve the expected reduction in vibration and, in some conditions, reduction was very poor. However, the reduction of vibration obtained on the three-dimensional DAVI isolated platform was excellent. A comparison of results obtained on the three-dimensional isolated platform and a conventionally isolated platform shows that the three-dimensional DAVI isolated platform had the lower vibration level and was less sensitive to changes in isolated weight or to changes in helicopter rotor speed (excitation frequency).

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14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Vibration Isolator Passive Isolator Antiresonant Isolator Low Frequency/Stiff Isolator Discrete Frequency Isolation Series Type Isolator DAVI						